AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 10, No. 30 WEEKLY. | NEW YORK, JULY 23, 1887. | $2.50 per Annum. SINGLE COPIES, 5 CENTS.

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New Hoisting Engine.

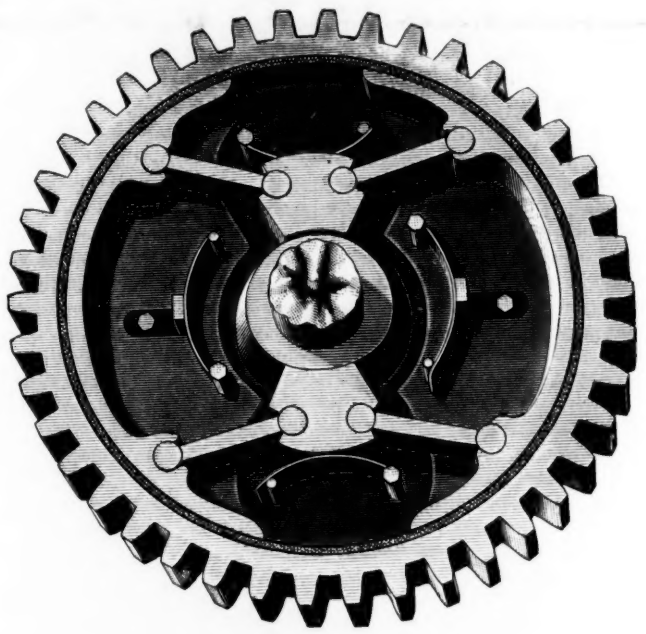
We illustrate herewith a new hoisting engine, the invention of Irving G. Hooper, and built by Alexander Traud, Newark, N. J. It is a friction clutch machine, in its general features being strong and durable, which is necessary to fit it for the rough usage to which such machines are subjected. It has, however, peculiarities of detail which will be briefly described, and which it is claimed make it extremely simple and adapt it to a wide range of work.

The bed of the machine, and all the journal boxes, are cast in one piece, no bolts or other fastening devices being required to hold these parts together. This avoids the liability to shake loose, from the constant jar machinery of this kind is subjected to. This construction also insures the parts always remaining in line, which is an important item.

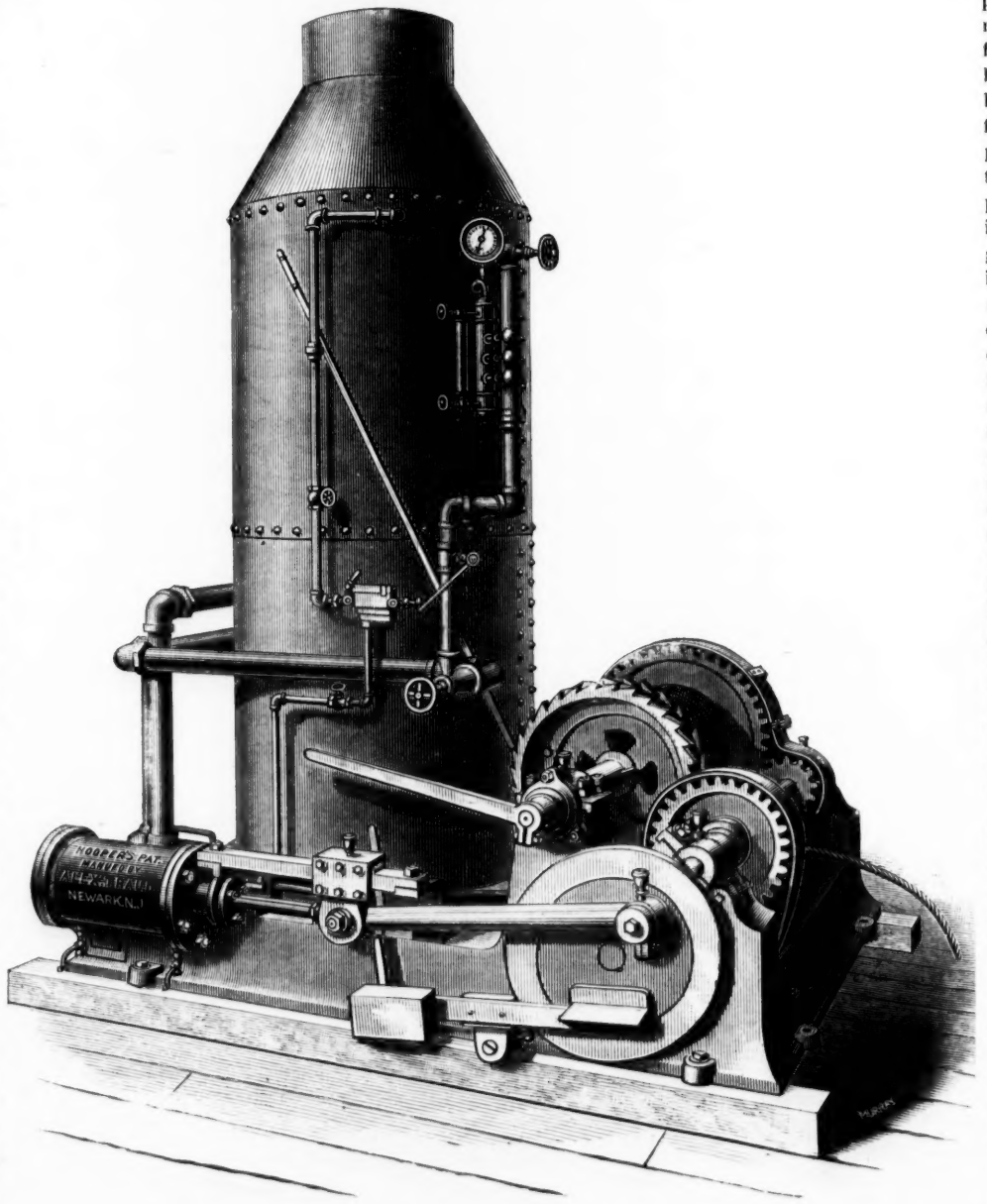
The machine may be changed from a double to single gear in a few minutes' time, and by unskilled labor. By loosening the cap screws the caps may be thrown back on the hinge, shown in the engraving; this furnishes a bracket bearing to receive the gear shaft, when the machine may be run with single gear. This provides for one machine doing the work of two as ordinarily constructed.

The friction, as will be seen by reference to the cut, is of novel construction. Two circular rings are forced outward by means of four toggles, which are direct in their action, being hinged in turn to the circular rings and to sliding blocks, giving powerful motion.

A sheet of vulcanized fiber is interposed between the friction surfaces, which can be readily renewed; this requires no fastening, being simply laid in place.



DETAILS OF FRICTION CLUTCH.



NEW HOISTING ENGINE.

Diffusion Battery for the Extraction of Sugar from Sugar Cane.

The Colwell Iron Works at the foot of Twenty-seventh street, New York, have just completed a diffusion battery for the extraction of saccharine matter from sugar cane. This machine is the result of recent investigations on methods and machinery for the extraction of sugar from cane and the processes for the purification of the extracted juices. These investigations have been conducted under the direction of the United States Government, for which also this machine has been built. It is believed that by the process of diffusion far better results can be obtained than by the old system of crushing the cane by rolls. The principle upon which the process of diffusion is based is simply to force a certain amount of water at a given temperature through the sugar cane chips confined in a number of cells, and thus extract the juice of the cane. Consequently the diffusion battery which has just been finished consists of twelve cells or cylinders, each having a capacity of 65 cubic feet; twelve heaters, and an exceedingly nice and compact arrangement of water, steam and air pipes, with necessary valves, cocks, etc.

The cells or cylinders are charged with sugar cane chips; through these cells and also through the heaters a certain amount of water is forced which will carry the juice of the cane with it, becoming richer and richer in its passage through the sugar cane, and as soon as this liquid has acquired the desired density or richness it is drawn off. Before the liquid acquires the right density it may have to be forced through all the cells or it may not; and therefore the arrangement of the pipes is such that this liquid can be forced in any one and any number of cells at a time.

The representative of the AMERICAN MACHINIST noticed two distinguishing features, which have been well designed in this battery, namely: First, the easy means provided for discharging from the cells the residue or exhausted chips; and, secondly, the ready means for charging the cells.

For the purpose of discharging the exhausted chip, the cells are supported by cast-iron columns, and placed high enough from the ground to permit a dump cart to be driven under the cells, to receive the exhausted chips. The carts can then remove at once the chips to the field or yard, where they can be placed in heaps, and allowed to partially decay before being used for manure. The cells are cylindrical in form; the bodies are made of thin boiler iron, with cast-iron tops and bottoms, the latter consisting of a frame and gate. These cells are placed in an upright position; that is to say, they are placed in a similar position to that of a steam cylinder in an upright steam engine. The gate in the bottom of each cylinder is hinged so that it can be swung open, thus allowing the exhausted chips to fall into the carts. The opening thus formed is equal in area to that of the horizontal cross section of the cell, which is also an important and necessary feature. The gates are counter-balanced, enabling the operator to quickly open these gates with ease. With gates as large in diameter as those used in this machine, and which have to be opened at comparatively short intervals, difficulty has been experienced in securing a tight joint; but with the device adopted in this battery for obtaining a tight joint between the gate and bottom frame of cell, all difficulty has been removed. This device is called the "hydraulic closure," and is made in the following manner:

A groove is cast around the opening of the frame; this groove is of a circular form. The metal on the face of the frame is then planed away so as to expose the interior of the groove, leaving in the face of the frame an opening whose width is equal to one-half of the interior diameter of the groove; in this is forced an endless thick rubber tube which nicely fills the groove, and slightly protrudes beyond the opening in the face of the frame. To this rubber tube is attached a short and straight rubber branch, and this is connected to the water supply pipe. The rubber tube is then filled with water at a pressure somewhat greater than that which pro-

duces the circulation of the liquid in the cells. When the gate is closed the projecting portion of the rubber tube is pressed against the flat surface of the rim of the gate, and thus producing quickly a perfectly tight joint. On account of the great elasticity of the tube it happens that even with fragments of chips left on the surface of contact the joint is formed over them with the same perfection as on the smooth iron. The water pressure, after it has been applied, remains constantly on the tubes, whether the gates are open or shut.

Just before the gates are to be opened the last charge of liquid is forced out of the cells by means of compressed air. By this method both loss of sugar and waste of water is prevented.

For the purpose of charging the cells the machine is admirably arranged. All the cells are placed in the circumference of a circle. In the center of this circle and above the cells a pivoted gutter is erected; this gutter has an inclination of about 45 degrees,and is arranged so that it can be quickly swung to any cell and charge it with cut sugar cane chips. For the purpose of conveying the cut chips up to the pivoted gutter an elevator is provided, which simply consists of a trough placed at an angle of 40 degrees; in this trough are made to move the scrapers or prongs fastened to an endless belt. These scrapers take the cut chips as they fall out of cane cutter and convey them to the pivoted gutter, into which they are allowed to fall.

In the cane cutter the knives are fastened to a horizontal revolving disk. These knives have a peculiar form, their surfaces being grooved so that in cutting the chips the latter will also be grooved. By this means, it is claimed, the packing of the chips by the approximation of smooth surfaces will be prevented, the free circulation of the diffusion liquids established, and a rapid and complete exhaustion of sugar promoted.

It is said that the juice of diffusion is a little less pure than the juice of the mill; the difference being due solely to the nature of the water employed; but diffusion applied to cane will allow the extraction of the maximum quantity of sugar from the cane.

The superior results expected by the use of this machine are not entirely groundless, since similar machines are successfully used in Europe.

This diffusion battery is to be placed in a few weeks on the plantation of Governor Warmouth, of Louisiana, and a series of experiments made to determine its value as a sugar extractor, and its superiority over the rolls. We trust the results may be as gratifying as expected, and if superior workmanship in the building of this machine will do it, then success is assured.

The Study of Rotative Bodies.

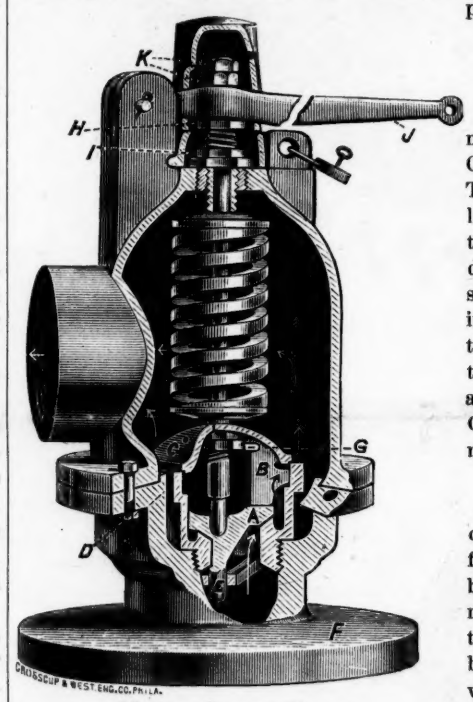
Mr. J. Wimshurst has recently made another application of his influence machine which may have useful practical results.

It is well known that the duration of the electrical discharge, whether it be a flash of lightning or the spark from a machine, a condenser, or an induction coil, lasts but a small fraction of a second. The impression made on the retina is not, however, of so evanescent a character. The duration of discharge does not exceed the one ten-thousandth of a second, whilst the retinal impression varies from one-tenth to one-fourth of a second, and may, according to the careful experiments of Plateau, even last one-half a second. It is in consequence of this persistency that a series of separate impressions are blended into one, producing thereby all the effect of absolute continuity.

On the other hand, a very rapidly moving body when illuminated for an exceedingly brief period of time must appear clearly delineated and perfectly stationary, because the duration of the illumination is but a small fraction of the time occupied by any part of the body in moving from any one position to the next following. Hence the clearness with which each of the colored sectors of a revolving Newton's disk appears when lit up by an electric discharge.

Mr. Wimshurst has turned these observations to account in the construction of a piece of apparatus which may be eminently useful in studying the behavior of any machine or body while in a state of very rapid motion.

The beauty of the arrangement is its great simplicity and the facility with which it may be adapted to any rotating body whatever. The whole novelty lies in the construction of what may be called the commutator. In its simplest form this consists of a copper wire twisted round the spindle of the rotating machine, and carrying at its extremities two small brass knobs placed at unequal distances from the center of the spindle. Opposite these, and independent of the rotating body, is a second pair of knobs, which are directly connected to the terminals of a Wimshurst or other static electrical machine. Once in every revolution of the rotating body, the two pairs of balls come near enough to each other to allow the electric discharge from the influence machine to pass. In every other position the distance between the knobs exceeds the striking distance, and no spark passes. Hence any desired portion of the rotating body is flashed into view once in every revolution; and, owing to the instantaneous nature of the discharge, that particular portion which is



MARINE SAFETY VALVE.

illuminated appears perfectly motionless. If the speed of the body be increased, the frequency of the electric discharges will be increased in the same proportion, and for high speeds especially, the part of the rotating body under examination will be permanently visible and will appear absolutely stationary. Any other section of the machine may be submitted to the same analytic scrutiny by merely turning the commutator into the corresponding position.

The apparatus of Mr. Wimshurst was shown last week at the Royal Society soiree, and subsequently at the Royal Institution. On both occasions it attracted much attention. Mr. Wimshurst used his box multiple plate machine, which furnished a current equal to one twelve-thousandth of an ampere with but very little expenditure of muscular energy. The discharge was so brilliant that the effects could be distinctly seen without lowering the gas in the apartment in which the experiments were made.—*Engineering.*

Marine Safety Valve.

The "lock-up" pop safety valve is being universally acknowledged among steam users as one of the most indispensable attachments to a steam boiler. In fact, its importance is scarcely second to the boiler itself. The very name "safety valve" suggests the importance of its duty, which is at all times and under all circumstances to automatically prevent the generation of an over-pressure of steam in the boiler on which it is placed. Defective or tamperable valves, which are misnamed "safety valves," often cause great destruction of life and property, and their attachments to steam plants ought to be vigorously condemned, and none but the best used.

The cut here shown represents an improved marine lock-up safety valve made in accordance with United States regulations under the Lynde patents. This has many advantages over the old form of Lynde valve, being much more compact and stronger, with perfectly tight case; its performance under pressure is very sensitive, prompt, and reliable. *A* is the valve, which is carefully ground to its seat, and of the best material for the service. *B* guide wings to valve, *C* concave disk forming the stricture, *D* the rim or bearings for guide wings, *E* center guide, being part of valve, *F* flange for securing valve to boiler; *G* is nut so arranged that when lever *J* is lifted the valve will also lift from its seat and give the relief opening required by the United States Government for marine service. *H* is the pressure stud to adjust the blow-off point; *I* lock nut on pressure stud; *K* lock nuts on center stud adjustable to lever *J* for lifting valve from seat.

This form of marine lock-up valve is made in sizes from 1½" to 6" diameter of opening, by J. E. Lonergan & Co., Nos. 211 Race and 212 Pembroke place, Philadelphia, Pa.

A Case of Spontaneous Combustion.

Shavings from the oiled wood used in the manufacture of planes at the Gage Tool Company's Works were put into a barrel on Thursday afternoon and twenty-four hours later were found to be almost on fire, their temperature being over three hundred degrees Fahrenheit. Before six o'clock the shavings were charred and smoking a few inches beneath the surface. This is a practical demonstration of spontaneous combustion, and illustrates how many mysterious and destructive fires may have originated. Oiled rags and waste will operate in the same manner.—*Vineland Evening Journal.*

It is said that Secretary Whitney has concluded to pay an English designer $15,000 for the designs of a new war vessel to be built in this country for our navy. We do not know that serious objections should be taken to this, yet we doubt if the money will be well expended. So far as we can see, the vessel, if built after Mr. Barrows' plans, will be weak compared with foreign vessels already afloat. Assuming that the Navy Department embodies the talent for determining what is wanted, it is not above the criticism in this matter which we believe it will receive. The price—$15,000—is cheap enough, but there is no evidence that it is to bring anything better than we already know how to build.

Crude petroleum is now being used in making salt at Warsaw, N. Y. It is said to beat coal; whether or no it will beat sunshine has not been fully demonstrated.

Modern Locomotive Construction.

BY J. G. A. MEYER.

FORTY-THIRD PAPER.

CROSSHEADS CONTINUED.

The pressure of locomotive crossheads against the slides caused by the thrust of the connecting rod should not exceed fifty pounds per square inch; and how to find this thrust we will presently explain. From this remark we conclude that the sliding surfaces of the wings of crossheads shown in Figs. 234 and 237 must contain a certain number of square inches, and consequently if the width of the slides is increased the length of the wings is made shorter, and when the length of the wings is shortened the slides are also shortened, which is always desirable. When four slides are employed, as shown in Figs. 234 and 237, we naturally obtain a wide sliding surface, and consequently the crossheads and slides shown in these figures are comparatively short; the slides are placed well up above the rails so as keep them free from dust as much as possible; the crosshead is light; in fact the whole arrangement is well adapted for eight-wheeled passenger engines, or engines having a four-wheeled truck in front.

The vertical distance between the slides, as shown in Figs. 234 and 237, should be only sufficiently great to admit the wing of the crosshead. In these figures it will also be noticed that the crosshead pin *P* is somewhat out of the center of the wings or sliding surfaces of the crosshead. The reason of this is that designers will always endeavor to make the crosshead, and consequently the slides, as short as possible. Now, because the required strength of the crosshead will fix the distance between the center *P* of the pin and the front end of hub this distance is limited, but by moving the wings a little ahead of the pin *P*, which can often be done, the distance from the front of the hub to the rear end of the wing is somewhat decreased, and, therefore, the slides can also be made a little shorter. But in the writer's opinion such practice should be avoided as much as possible, and the pin *P* should be kept central with the wings or sliding surfaces of all crossheads; by so doing the latter will wear more evenly.

The type of crosshead of which a side elevation is shown in Fig. 241, an end elevation in Fig. 242, and a plan in Fig. 243, is occasionally used for eight-wheeled passenger engines, but the writer believes that this crosshead is better adapted for mogul engines, such as shown in Fig. 2 and consolidation engines, such as shown in Fig. 4, and for these engines it is very often used. This design of crosshead is suitable for cast-iron, of which these crossheads are made, and the dimensions here given are suitable for a cylinder 20 inches in diameter. The crosshead pin *P* is either made of steel or wrought-iron case-hardened. The head of the pin is always placed towards the driving wheels; by so doing—as must be obvious—the cylinders can be brought closer together and still leave room enough for the crosshead to pass the crank pin of the front driving wheels. The side of the crosshead in which the head of the pin *P* is inserted we shall hereafter call the inner side of the crosshead, and the opposite side the outer side. In the majority of crossheads of this type brass gibs g_2 g_2 (Fig. 242) are used. In order to take these out quickly when necessary, or to put in liners when the wear demands it, the outer flanges f_2 f_2 are bolted to the crosshead; the inner flanges are cast to it. These flanges and the lips cast on the gibs will prevent the latter from slipping out of place. In designing a crosshead one great object aimed at is to make it as light as possible, and still leave it strong enough to meet any emergency; consequently the distance between the slides must be as short as possible. This distance is determined by the oblique positions of the connecting rod. The method employed for finding the distance between the slides will be explained hereafter. Some master mechanics raise an objection to this type of crosshead, because when this is used in engines which have driving wheels of comparatively small diameter, as is the case in freight engines, the slides are brought too close to the rails and consequently exposed to the dust, which will wear the slides and crosshead too fast. To avoid this difficulty, crossheads are used of which Fig. 244 is a side elevation, Fig. 246 an end elevation, Fig. 247 a plan, and Fig. 245 a view of the crosshead pin *P*. This design of crosshead is adapted for wrought-iron or cast-steel, and is made of either one or the other material. The dimensions here given are suitable for cylinders 20 inches in diameter with a maximum steam pressure of 120 pounds per square inch. Wrought-iron crossheads are generally very expensive to make, and if wrought-iron crossheads are insisted upon, then this design recommends itself, as the expense connected

with making a crosshead of this type is comparatively small. Referring to Figs. 244 and 246 it will be seen that this crosshead simply consists of a hub $H H_2$, to which the piston rod is keyed. To this hub are forged two deep flanges F, F_2, F_2. These flanges extend upwards and terminate a little below the upper slides $S S_2$. Between these flanges a cast-iron block $h h_2$ is bolted by a number of bolts $\frac{3}{4}$ of an inch in diameter; these bolts extend through the flanges and the cast-iron block. To the upper and lower faces of the block h h_2 the brass gibs g g_2 g_2 are fitted. The gibs are held in position sideways by the flanges F_2 F_2, and endways by the lips cast to the gibs; for additional safety two pins r r one inch in diameter are driven through the gibs g g and the block h. The flanges of the upper gib g_2 slide along the sides of the upper slide, and the flanges F F_2 F_2 slide along the sides of the lower slides, and thus forming good deep sliding surfaces which will guide the end of the piston rod in a straight line laterally, although not with such steadiness as the crosshead shown in Fig. 241 will do, and in this respect the crosshead represented in Fig. 244 is somewhat inferior to the one shown in Fig. 241. The gibs in the crosshead shown in Fig. 246 are not so readily removed as in the crossheads shown previously, because in the case before us, in order to take out the gibs the upper slide must be taken off, besides taking out all the bolts which hold the block h, and this is not always an easy matter. The distance from the center of the crosshead pin P to the lower surface of the bottom slide must be as short as possible; it should be only sufficient to allow the connecting rod when in an oblique position to clear the edge o of the lower slide.

Fig. 248 represents a side elevation, Fig. 250 an end elevation and Fig. 251 a plan of another crosshead and slide; and Fig. 249 shows the crosshead pin P.

This crosshead is made of cast-iron, and, as will be seen, requires only one slide. This design of crosshead should only be used for small locomotives; the dimensions here given are suitable for a cylinder 15 inches in diameter, and indeed this crosshead is seldom used on engines having cylinder larger than 15 inches in diameter. This crosshead—with the exception of the plate F F_2 is cast in one piece, the cast-iron plate F F_2 is bolted to the crosshead; this arrangement allows the brass gibs to be readily placed in position, and quickly removed when necessary. The distance between the slide and the pin P must be such which will allow the end O of the slide to clear the connecting rod when in an oblique position. The writer believes this crosshead to be inferior to all the other crossheads shown, because in his opinion this crosshead will not guide laterally the end of the piston rod as steadily as the others. Yet it is a very cheap crosshead, and seems to work well in small engines.

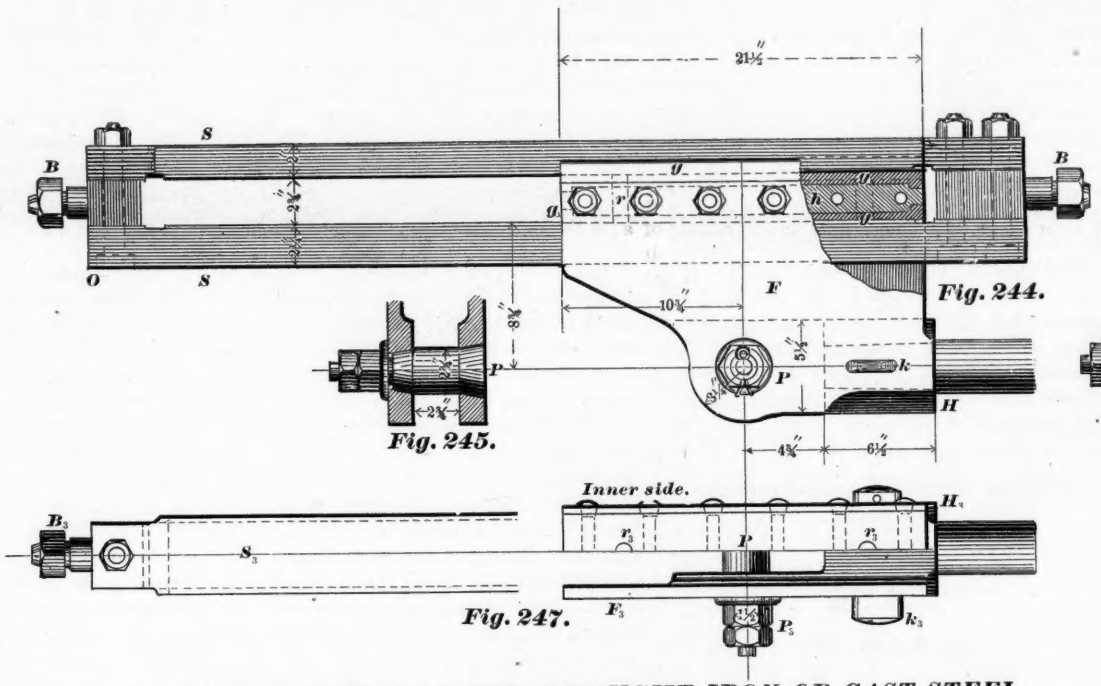


Fig. 244.

Fig. 245.

Fig. 246.

Fig. 247.

DESIGN SUITABLE FOR WROUGHT IRON OR CAST STEEL.

Cylinder 20 inches diameter, 24 inches stroke.

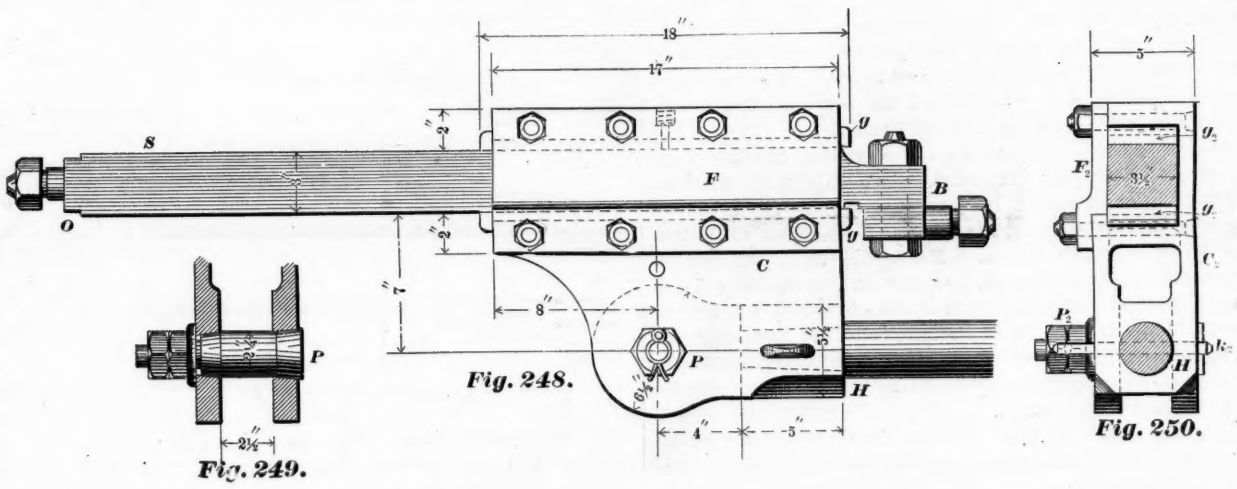


Fig. 248.

Fig. 249.

Fig. 250.

Fig. 251.

DESIGN SUITABLE FOR CAST IRON.

Cylinder 15 inches diameter, 20 inches stroke.

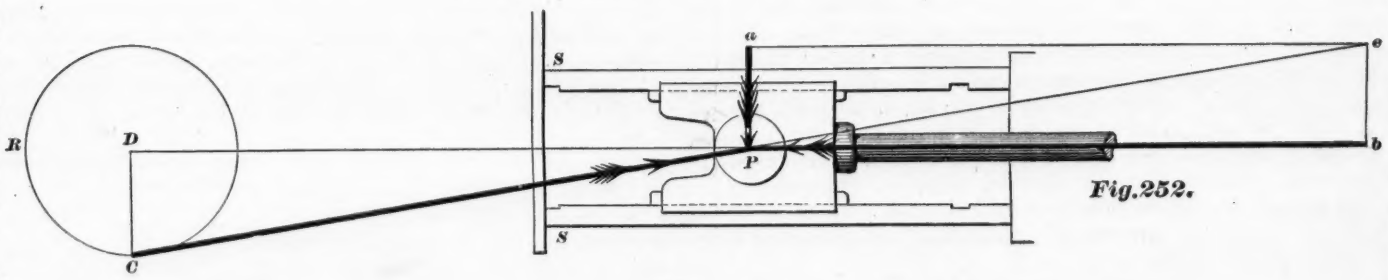


Fig. 252.

TO FIND THE THRUST OF THE CONNECTING ROD.

When the connecting rod stands in an oblique position, for instance such as will occur when the crank is at half stroke, the connecting rod will force the crosshead against the slides; and this force, which presses the crosshead against the slides, is called the thrust of the connecting rod. The amount of this thrust, or the magnitude of this force, can be found by two methods: The graphic method, and by calculation.

We will first explain how this thrust can be found by the graphic method.

Fig. 252. Let D be the center of the driving axle, C the center of the crank-pin, P the center of the crosshead pin, S S the slides, D b the center line of motion, and the circumference R C the path of the center of crank-pin. It is also assumed that steam will follow full stroke. It is required to find the thrust of the connecting rod, or the pressure of the crosshead against the slides.

The total steam pressure on the piston is transmitted through the piston rod to the crosshead pin P, and from thence it is transmitted through the connecting rod to the crank-pin C. The direction in which this steam pressure acts is in the direction of the center line of the piston rod, and in the direction of the center line of the connecting rod.

At the beginning of a stroke, the center line of the piston rod, and the center line of the connecting rod, will lie in one and the same straight line, and therefore we assume that in this position there will be no thrust, or, in other words, the steam pressure will not cause any pressure between the crosshead and the slides.

When the crank stands perpendicular to the center line of motion D b, the angle formed by the line D b, and the center line C P of the connecting rod, will be the greatest, and therefore we conclude that in this position the thrust of the connecting rod will also be the greatest. It is now our object to find the intensity of the thrust, or the magnitude of this force, when the crank D C stands at right angles to the center line of motion D b.

Draw the center line of motion Db, on this line, take any point, as D, to represent the center of the driving axle; through the point D draw a line DC perpendicular to the line D b, and make D C equal to the length of the crank. From C as a center, and with a radius equal to the length of the connecting rod, draw a short arc cutting the line D b at the point P; this point will be the center of the crosshead pin, and the line C P will represent the center line of the connecting rod. Prolong the line C P to e, making P e equal to C P. Through the point P draw a line P a perpendicular to the line D b; through the point e draw a line e b parallel to P a, and again through the point e draw a line e a parallel to P b; then P a e b will be a parallelogram, which is called the parallelogram of forces.

Now in mechanics, which is that branch of science which treats of the effects of forces upon matter, it is shown that forces can be completely represented by straight lines, or, in other words, the magnitude of a force, and the direction in which it acts, can be represented by a straight line. It is also further shown that in a parallelogram of forces, such as we have just completed, that the magnitudes of the forces are proportional to the length of the sides of the parallelogram of forces, that is to say if the length of the side P a in our parallelogram of forces is equal to one-half the length of the side P b, then the force represented by the side P a will be one-half as great as the force represented by the side P b; or again, if the length of the line P a is equal to one-quarter of the length of P b, then the force represented by the line P a will be one-quarter as great as the force represented by the line or side P b. How these principles can be applied to practice will be explained in our next paper.

Locomotive Torches.

BY JOHN A. HILL.

I never ran or saw a locomotive but what was provided with some sort of a torch or light to enable the runner to see while he deposited the juice of slipperication upon the frictional bearings of the locomotive, and done sundry other little necessary jobs while the sun was in China and most people in bed. Some of these were made of tin and looked like a miniature teapot, some were made of copper, and looked like a pocket flask; some of brass that looked like a powder horn, or possibly a torch, and some of iron that looked like thunder. But I used them and tolerated them, and burned the hair off my hands and face with them, and dropped them through and under the engine, and lit them forty times in a windy night, and wiped them forty times in a day, and filled them every time I wanted them, and put a new wick in every time I thought of it, and swore at them often, and consoled myself that they were "standard" and just what the rest of the boys had, and got so I forgot all about their shortcomings in daylight, and remembered them at night, and often wound a piece of greasy waste around a packing hook and used that, and let the torch rest in its grease and glory and counted myself well rid of it. But a short time since an apprentice came to me and said if I would rustle the pipe and tell him how I wanted it made he would make me a dandy, and I took him up. Then I commenced to do just what I should have done ten years ago—commenced to think, to study the bad points of my old torch and what changes I wanted made in the new one. The company who run a railroad by grace of my valuable services make a standard torch. They are made of old 2-inch flues with a rough cast bottom soldered in, and a brass ring soldered on top, threaded to receive the burner; this is made of brass, and if you had a bird's-eye view of it, or a cross section, or if it was sawed in two lengthwise the edge would look like Fig. 1. It is about 12 inches high, weighs about three pounds, unfinished, rough, homely, oily excuse for a torch, and I don't think its shape is the fault of the men who made it or ordered it made, for not one of them ever used one, and I doubt if any one of them ever saw one with a wick in it, and they should not be expected to know any more about it than I know about the grade of the golden stair, or a Hottentot knows about astronomy.

First, it has a taper hole for the wick, and the constant jar of the engine works the wick down into the body of the torch just when you want it—well, I'll have mine made straight inside.

Second, the burner is so thin on top that if the wick burns off too close to catch hold of and pull up, and you have to jar it up by striking the top down against a tie, the deck or some other wooden object, it jams, cracks, etc., and catches the wick so that it will go neither up nor down—well, I'll have a ring about ¼ of an inch in area, turned up on the outside of that burner top so that it will stand thumping.

Third, the wick knots all up just under the burner when you thump it down, and it refuses to be coaxed up—well, I'll have a tube of perforated tin soldered into bottom of the burner in a little recess turned to fit it. This will keep the wick straight and prevent working down.

Fourth, the wick keeps feeding up oil by capillary attraction, or pure cussedness, and it runs all over the outside of torch and greases your hands and clothes, and gets on fire, etc.,—well, I'll have a little cup turned up at bottom of burner to catch this oil, and when it is lighted this extra oil will burn up on the burner or is easily wiped off.

Fifth, too heavy, too big to handle nice, and too short to get under engine with—well, mine shall be of thin brass tube 1¼ inches and 24 inches long, then I can reach around it with my hand, can stick it through wheel over driving box and examine the interior territory without crawling under myself. Then the wick tube is but 8 inches long, and the oil will stand away from the wick and shut off some of that capillary business; it will hold lots of oil, and I will have a round bottom with no flare to it, and a brass ring shrunk around the center of torch, and stick it through a brass hole in a brass bracket, and——. But, says the apprentice: "How will you stand it up on end with no flaring bottom? See, they are all standing up in a row there in the store room." "Yes." I thought they are never stood up after they leave it, and are never used in the store room; one would never stand up on the road, if you wanted it to, and you never want it to; and the big bottom is heavy, in the way, and keeps us from using the best form of bracket. And now that torch is done, and a cross-section of burner looks like Fig. 2; and its wick stays where you want it, and it don't slobber below the cup, and it don't jam when knocked on a tie; and it is so slender it is light; and so long it don't burn your hands; and if my brothers on the footboard all had one just like it, they would all vote it "a thing of beauty and a joy forever."

American Railway Master Mechanics' Association.

REPORT OF COMMITTEE ON PROPORTIONS OF LOCOMOTIVE CYLINDERS.

To the American Railway Master Mechanics' Association:

Your committee on "Proportions of Locomotive Cylinders" beg to make the following report:

Circulars embodying questions bearing on the subject were printed and distributed by your secretary, and in addition a few copies were forwarded to locomotive superintendents of Great Britain.

Judging by the very small number of answers received, it would appear that the matter is generally considered a subject well understood, and not open to further discussion. Much difference of opinion must exist, however, or we should not find in examples of modern locomotive construction, such variations in the ratio between tractive power per pound of mean effective cylinder pressure and weight available for adhesion.

Communications in reply to the circular have been received from the following gentlemen: Mr. J. D. Barnett, of the Grand Trunk Railway; Mr. J. McGrayel, of the Des Moines and Fort Dodge Railway; Mr. James Meehan, of the Cincinnati, New Orleans and Texas Pacific Railway; Mr. Angus Sinclair, of the "National Car and Locomotive Builder;" Mr. Thomas B. Twombly, of the Chicago, Rock Island and Pacific Railroad; Mr. S. G. G. Copestake, of the Glasgow Locomotive Works, Scotland; and from Mr. F. W. Webb, of the London and Northwestern Railway, England.

MR. BARNETT gives the following rule for finding the diameter of cylinder when stroke of piston, mean diameter of driving wheels and weight on same, also boiler steam pressure, are known, viz.: the square root of the adhesive power, multiplied by the mean diameter of drivers, divided by the mean effective cylinder pressure, multiplied by the length of stroke—all weights being expressed in pounds, and measurements in inches.

This rule requires the assumption of a coefficient for adhesion, also of the mean effective cylinder pressure. Mr. Barnett, in the example quoted by him, uses one-fifth as the coefficient, and states that as the work to be provided for is the maximum, the mean cylinder pressure should be fully nine-tenths of the initial pressure, which should be not less than seven per cent. below the full boiler pressure.

MR. MCGRAYEL states that he adopts practically the same rule, but his experience teaches him that when using a fraction over fifty per cent. of boiler pressure, as the mean cylinder pressure it is necessary, in order to obtain good results, to use one-sixth as the coefficient for adhesion in the case of passenger engines, and one-seventh for freight and switch engines.

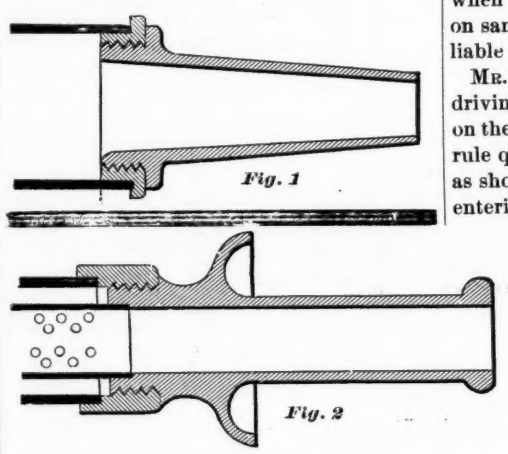
MR. JAMES MEEHAN reports using the same rule, but assumes 90 pounds as the mean cylinder pressure in conjunction with ⅛.17 as coefficient for adhesion.

MR. ANGUS SINCLAIR gives no rule, but states that the proportions of cylinder and the elements of adhesion are subject to a proper ratio, and that any material deviation from the same should be considered a mechanical blunder.

MR. THOS. B. TWOMBLY reports making use of the rule found in Forney's Catechism of the Locomotive, and as follows: Multiply the total weight on the driving wheels, in tons of 2,000 pounds, by 5, and then by the circumference of drivers, in inches, and divide by 4, the quotient being the cubical contents of each cylinder.

This rule was proposed by Mr. Forney, in consequence of the results obtained with engines at the time his excellent book was written, but on account of the considerable increase in boiler pressure generally adopted since that time, it is obvious that the rule now requires modification to suit the altered conditions.

MR. COPESTAKE reports using the same rule, and like Mr. Barnett, assumes one-fifth as the co-efficient for adhesion, but uses sixty-three per cent. of boiler pressure, as the mean cylinder pressure. Like Mr. Twombly, he makes no allowance for wear of tires, the diameter of wheels over the tires when new, being used in the calculation.



LOCOMOTIVE TORCHES.

MR. F. W. WEBB states that he has no hard and fast rule; but in ordinary practice adopts a 24 inch stroke of piston, and arranges the diameter of cylinders so that the tractive power at starting, with full boiler pressure, does not exceed the adhesive power under the most favorable circumstances.

MR. BARNETT considers that no deviation should be made from the rule, whether the engine in question be for passenger, freight, or switching service. Mr. McGrayel, as before stated, recommends the co-efficient for adhesion to be one-sixth for passenger, and one-seventh for freight and switching engines. Mr. Copestake expresses the opinion that the rule, as given by him, should apply to both passenger and freight engines, but in the case of switching engines, the stroke may be longer in proportion to the diameter of the cylinder. Mr. Webb states that he adopts the same rule for both passenger and freight engines.

In reply to question number 5 of circular, Mr. Barnett states:

"When tractive force is in excess of adhesive weight, the results, although not necessarily bad, usually are so, if the engine is in the hands of but an ordinary engineer, as the engine slipping her wheels so easily is often allowed to do so, causing not only excessive wear of tires and machinery, but also wasting the steam and throwing away the fuel. Nevertheless, within the narrow limits permissible in locomotive design, the larger the cylinder, the more economically the engine can be worked in the matter of fuel consumption. This was the opinion and practice of M. Marie, of the Paris and Lyons Railway, and the experiments then carried out (and recorded in the Proceedings of the Institute of Mechanical Engineers, May, 1884) with an eight wheel coupled passenger engine, on mountain service, having cylinders 19¼x26 inches, wheels 49⅜ inches diameter, with about 58,000 pounds on drivers, show a consumption of 2.88 pounds of fuel per indicated horse-power, or 3.27 pounds per actual horse-power, and but 30 pounds of wet steam per horse-power developed. This was achieved with steam at 128 pounds pressure, cutting off at 19 per cent. of stroke, weight of train 163½ tons, speed 17½ miles per hour, on a continuous grade of 1 in 53½. However, whether all that is involved in such expensive construction is justified in a district where fuel is cheap, is open to serious question." He further states, when referring to another portion of the subject: "In other words, it is not advisable to give an engine having a boiler pressure of 150 pounds, driving wheels of 66 inches mean diameter, and a weight on them of 66,200 pounds, cylinders of larger cubical capacity than 17x24 inches, without the conditions of daily service under which the engine is expected to work, are so exceptional, that it is a matter of great importance that very little water should be used by the engine, or that she must be very economical in fuel; under which circumstances it would be advisable to make a decided outlay in cylinder clothing, even to the extent of steam jacketing.

MR. MCGRAYEL states that when the weight on drivers is less than in the proportion recommended by him, he finds that engines do not give satisfactory results, on account of slipping, which necessitates use of sand, and consequent wear of tires; and when wheels are slipping, and are caught on sand, crank pins and side rods are very liable to be bent or broken.

MR. MEEHAN states that the weight on the driving wheels is a point of great influence on the efficiency of the engine, and that the rule quoted by him gives splendid results, as shown by the decreased tire wear. On entering the service of the C. N. O. & T. P. Railway, he found the Northern Division, which is very hilly, with grades of 60 feet per mile, 6 degree curves, and 27 tunnels, stocked with engines which were of the average character as to weight on drivers. These engines were substituted by new ones, of practically the same cylinder capacity, but with greatly increased weight per driving axle, and as a result, the road-master reports greatly decreased surface wear of rail, and he himself finds the wear of tires much reduced. He believes this has been attained by reduction of slipping, on account of increased weight on drivers.

MR. TWOMBLY states that engines in which the ratio of weight on drivers to tractive power is above the average, give better results, the wear and tear of machinery being less, and life of tires prolonged.

MR. COPESTAKE says he generally takes the ratio of cylinder, and adhesive power about equal, but if anything, would give an excess, not exceeding 10 per cent. to the adhesive power.

To illustrate the difference in cylinder dimensions, when calculated by the various rules recommended by the gentlemen who have expressed their views on the subject, the following figures are of interest:

Passenger engine; stroke of piston, 26 inches; mean diameter of driving wheels, 61 inches; weight on drivers, 60,000 lbs.; boiler pressure, 160 lbs.

Barnett..... $\sqrt{\frac{\frac{60,000}{5}\times 61}{134\times 26}}$ = 14.5" dia. of cyl.

McGrayel..... $\sqrt{\frac{\frac{60,000}{6}\times 61}{85\times 26}}$ = 16.6" " "

Meehan ..... $\sqrt{\frac{\frac{60,000}{6\ 17}\times 63}{90\times 26}}$ = 16.2" " "

Twombly. . ... $\sqrt{\frac{\frac{60,000}{2,000}\times 5\times 198}{4\times 26}}$ = 16.9" " "

Copestake..... $\sqrt{\frac{\frac{60,000}{5}\times 63}{101\times 26}}$ = 16.9" " "

Webb... ..... $\sqrt{\frac{\frac{60,000}{3.7}\times 63}{160\times 26}}$ = 15.67" " "

Proposed rule. $\sqrt{\frac{\frac{60,000}{4}\times 61}{136\times 26}}$ = 16.1" " "

In the consideration of this subject, one has to deal with two indefinite quantities, namely, the mean effective steam pressure in the cylinders, and the co-efficient of adhesion; and both of these have to be assumed before any calculation can be proceeded with.

The first, or mean effective cylinder pressure is of course primarily governed by the boiler pressure, and is secondarily subject to alteration by point of cut-off and speed—it is assumed that the engine is worked with the throttle wide open, and that the steam passages are of proper dimensions, otherwise the pressure will be influenced by these causes.

Few railways are free from grades which necessitate engines being worked to a greater or less extent, nearly up to their ultimate capacity, and in the event of starting on such grades, as well as from stations generally, of being worked full power; hence it appears proper that the mean effective cylinder pressure should be placed sufficiently high to cover such cases, and your committee are of opinion that 85 per cent of the boiler pressure be considered the M. E. C. P. in the formula.

The second indefinite quantity, or the co-efficient of adhesion varies as the condition of the surface of rail changes, and according to Molesworth, from $\frac{1}{3.7}$ to $\frac{1}{11.2}$ the former being due to a perfectly clean and dry rail; the latter to a slightly moistened, or frosted rail. In different parts of the world it is doubtless possible to find places where the average co-efficients for the year will vary to such an extent, as to warrant special allowance being made to suit the circumstances; but in the United States it may be safely stated that exceptional climatic peculiarities, sufficient to justify any material deviation from a standard rule, do not exist.

As passenger engines are worked so as to produce a M.E.C.P. of 85 per cent. of the boiler pressure, for a very limited fraction of their total mileage, it would appear not improper to use the coefficient one-fourth, or that due to a dry rail, for calculating the proportions of passenger engines.

Freight engines being worked to their ultimate capacity to a very much greater extent than passenger engines, it would be consistent to increase the coefficient to say $\frac{1}{4.75}$; and in the case of switching engines, generally worked full stroke, a coefficient of $\frac{1}{4.5}$ would be required to obviate the excessive use of sand, to prevent slipping on the more or less greasy rail generally encountered in yards where this class of engines is employed.

An inspection of tabular statement herewith shows that among engines of recent construction, very great variations in their relative tractive power and adhesive weight exist.

In the case of American passenger engines, and using the formula recommended by your committee, it is found that the N. Y. L. E. & W. mogul engine built by the Baldwin Company has an excess of adhesive weight of 26,600 lbs., or 38.7 per cent.

The eight-wheeled engine built by the Mason works shows an excess of over 12,400 lbs., or 22.3 per cent.; while the Lake Shore and Old Colony eight-wheeled engines are deficient in the same respect to the extent of 6,500 lbs., or 9.2 and 9.5 per cent., respectively.

Among foreign passenger engines the Belgian State locomotive has an excess of adhesive weight of over 20,000 lbs., or about 46.5 per cent.; the New South Wales mogul an excess of nearly 16,000 lbs., or 25.2 per cent.; while the Great Northern express engines, with 91½ inch driving wheels, are deficient to the extent of 12,600 lbs., or over 24.8 per cent.

Among freight engines of American build the variations are not so great. The Union Pacific Wootten Consolidation engine has an excess of 18,900 pounds, or 21.8 per cent.; the Baltimore & Ohio mogul an excess of 12,500 lbs., or 16.7 per cent.; while the Baldwin decapod shows a deficiency of 18,300 lbs., or 12.5 per cent.

Of foreign freight locomotives, the six wheels coupled engine of the Great Eastern Railway has an excess of 16,200 lbs., or 24.6 per cent.; while the Dubs consolidated engine, built for Brazil, has a deficiency of 14,900 lbs., or nearly 14.3 per cent.

Of switching engines, the Brooks six-wheeled switcher has a deficiency of 13,900 lbs., or 17.4 per cent.

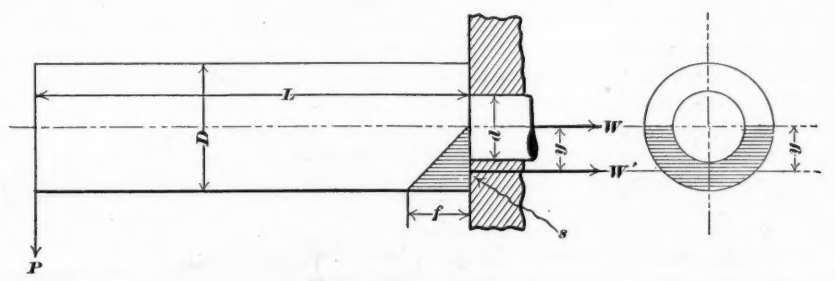
Your committee recommend, for general purposes, the use of the following formula:

$$\frac{d^2 \times S \times P \times 0.85 \times C}{D} = W$$

D = Diameter over tires when half worn;
d = " of cylinder;
S = Stroke of piston;
P = Boiler pressure;
W = Weight on driving wheels;
C = Coefficient for adhesion. $\frac{1}{4}$ for passenger engines, $\frac{1}{4.75}$ " freight " , $\frac{1}{4.5}$ " switching "

Should extreme economy in fuel and water consumption be considered imperative, and of greater importance than additional cost of superheaters, and steam jacketed cylinders, and main enance of same, a considerable increase of cylinder power would be admissible, so as to allow the average work to be performed with a correspondingly earlier cut-off, and greater ratio of expansion.

The unsatisfactory results, however, obtained with the ordinary link motion from the wire-drawing of steam, when cut off much earlier than at 25 per cent. of the stroke, point to the desirability of using some other type of valve motion, when the extreme practice above referred to is contemplated.



MACHINE DESIGN.

Your committee beg to thank members of the association and others who responded to the circular, for information used in the preparation of this report, which is respectfully submitted.

CHARLES BLACKWELL,
F. L. WANKLYN,
T. E. BARNETT, } Committee.

DISCUSSION.

MR. CHARLES BLACKWELL explained that in order to make the matter on hand clear to members he had got a table printed giving a few dimensions and weight on drivers of a few locomotives of well known make.

MR. HICKEY found it difficult to arrive at the proper proportion of cylinders, driving wheel diameters and weights thereon. We have on our road two classes of 17x24 inch locomotive. One of these, the lighter, weighs on the drivers 51,000 pounds, or a total weight of 12,750 pounds per wheel. The other class, the heavier, has a total weight on the drivers of 56,000 pounds, or a total weight of 14,750. The diameter of these wheels is 62 inches outside tire and we carry a boiler pressure of 140 pounds. We find the heavier of this class haul, on an average rail, 30 net tons, or a car and a half more than the lighter ones, though they wear the tire evidently as much as the lighter, for the reason that if they should slip it causes a greater wear. The lighter ones use fuel to a greater extent than the heavier. We use on our road an average weight of about 16,000 pounds per wheel, 62 inch wheel, 17x24 inch cylinder, and carry a boiler pressure of 140 pounds. For a 56 inch wheel we use a total weight on drivers of 64,000 pounds, or a weight per wheel of 16,000 some odd pounds. When we exceed that we find the tire wears very fast; and that should be a maximum load for driving wheel. When more weight is desired it had better be placed on more wheels than four.

SECRETARY SETCHEL: There is one point in the report that has been contrary to my experience. It is stated that, "nevertheless within the narrow limits permitted, the larger the cylinder the more economically the locomotive can be worked in the matter of fuel consumption." I have known a great many cases where that idea seems to prevail. One case where the master mechanic thought it only necessary, in order to have a big engine, was to take off cylinders and put on larger ones; then when harder work was to be done the big engine was hauled out and invariably failed to do the work.

A cylinder far beyond the boiler capacity to supply, and steam runs down. I think that it is not true that the larger the cylinder the more economically an engine can be worked, because when steam falls the consumption of fuel increases. A smaller cylinder better filled would be far more economical

MR. BARNETT: The sentence quoted by our worthy Secretary comes from myself and is hardly complete, seeing I qualified the statement. It refers to using large cylinder capacity, not with the purpose of getting an increased power out of the engine, but in getting increase of economy in the use of fuel, because the larger cylinder gives the opportunity of a larger grade of expansion. But under ordinary conditions of practice an excessive expansion of steam is not economical, because you admit in your cylinder at high temperature, and in expanding to low pressure you cool down the walls of your cylinder, and on the admission of steam into the cylinder, a large proportion is at once condensed; then when the cut-off occurs evaporation commences at the same time. This water is evaporated, and therefore interferes with the perfect utilization of the heat contained in the steam. If the steam were a perfect gas that effect would not exist. But steam is not a perfect gas, therefore if you cool your cylinders too low by a perfect expansion you fail about realizing economy in your fuel bill. The sentence is qualified by "the cylinders being clothed or even steam jacketed." Certainly after you have got up to the limit of cylinder capacity which is given in that report no increase of power can be obtained by lengthening or increasing the diameter of your cylinder. The whole question really turns on certain assumptions, and because the assumptions of the various persons are different the formula when applied gives various results. In that question on the point of cut-off there are various pressures assumed. My own assumption was this: that the steam in getting from the boiler into the cylinders loses a certain amount of pressure. In many of our old engines the falling pressure was 17 per cent. No person to-day should build an engine in which the falling temperature is more than 7 per cent.

MR. SINCLAIR: It is a hard matter, analyzing a report of that kind as it is being read. To get hold of it properly one needs to take it and study it out, consequently it is hard to discuss the report intelligently now. One of the most valuable features about it is likely to be that it will prevent the over-cylindering of engines to a great extent. Those who are designing locomotives, if they take up the formula given it will cause less cylindering in the future than in the past. If you have a recognized formula—if the Master Mechanics' Association says, "There is a proper design for a locomotive, if it is deviated greatly from you will have an expensive engine"—it will stand in good stead to many men in that department. Very often, instead of adding an inch to the diameter the same result would be obtained by adding a little to the pressure of the boiler. The material is at the hands of every designer or builder now to make a particularly strong boiler, and he can use high pressure steam. Take an engine using steam of 100 lbs. boiler pressure, that is particularly low. Suppose that engine to have cylinders 20x24. Now, take and raise your steam to 145 pounds, and apply it to an engine with cylinders 16x24, and it will do as much work as that with the large cylinders, and there will be a much smaller area of cylinder surface to waste power by extra friction, and steam by surface that acts as a condenser, and the cylinder is a more perfect condenser than is generally understood. As regarding this matter of cut-off with locomotives, we never reach the point of cut-off where the expansion is a detriment to the engine. In the most economical engines in use they expand the steam 8 or 10 times. The locomotive never expands it 4 times, or very rarely. Your expansion, taking it at the end of a stroke, is only 4 times and cutting off at 6 inches the release will take place at 16 inches, so you really have no more than two expansions. I cannot see from all the indicator diagrams I have examined that the expansion is so great as to cool the cylinders enough to be detrimental.

MR. LAUDER: I would like to say just a word in affirmation of Mr. Sinclair, and that is, the large high pressures. That doesn't strictly come within the discussion on the report just read, but I want to say that my observation, for the past year at least, in carrying high pressure is, that it is one of the things we have got to come to if we want to get greater power and greater economy. We are carrying now on some engines as high as 170 lbs. It is very much better to use smaller cylinders and carry higher pressure than to enlarge the cylinders and carry lower pressure. The bane of the engines in America is small boilers in comparison to the size of the cylinders. We have steel tires, steel rails, better road bed, and there is nothing in the way of using high steam.

LETTERS FROM PRACTICAL MEN.

"Suggestions in Machine Design."

Editor American Machinist:

I thank "Exact Way" for having pointed out the error in the preliminary work of the formulæ accompanying my notes on springs.* I was well aware of the existence of the small error caused by the neglect of the angle of the helix, and attempted to make a set of formulæ on the basis suggested by "Exact Way," but was unable to construct a set which should be in good form for practical use, although it was, of course, as easy to make formulæ on one basis as on the other.

I had intended to note the existence of the error in the text, but inadvertently omitted to do so. The statement should have been

$$l = \pi \text{ D N nearly} =$$

the length of wire in the spring.

To investigate the error caused by the omission of the angle of the wire, let us take the case of the spring cited as an example in the "suggestions" in which $d = 0.13''$ and $D = 0.52''$. The length of the wire by the approximate formula is

$$l = \pi \times 92 \times 0.52 = 150.3+$$

while the length by the exact formula is

$$l = \sqrt{150.3^2 + 15^2} = 151.05+$$

showing a difference of less than ½ of 1%, an error, to avoid which would hardly compensate for the additional complexity of the formulæ necessary to include it; especially as it is less than the variation in springs as nearly alike as it is possible to make them.

The error introduced by neglecting the change in the angle of the helix as the

* The articles referred to in the following appeared in the AMERICAN MACHINIST of May 21, and June 11 and 25, 1887.

spring deflects is even less in amount, and while it should be known that it exists, it is hardly necessary to consider it in order to obtain results considerably closer than "rough approximations."

I wish also to thank Mr. Bilgram for suggesting a better construction of cone clutch than the one shown in the ninth paper, and also for making the suggestion over his own name, instead of under cover of a *nom de plume*.

I regret to learn that "young persons" are being misled by my remarks as to the securing of long studs subjected to transverse loads, and must apologize to "Easy Way" for not having furnished a demonstration of what I had erroneously supposed to be a nearly self-evident proposition.

It will be a surprise to most designers, I think, to learn that an overhanging stud or beam of any kind can be reduced at its insertion into the supporting piece without being weakened thereby, no matter what the character of the stress to which it is subjected, and they will be curious to find out in what manner "Easy Way" will proceed to demonstrate the truth of his statement that "the reduction in diameter at the neck does not weaken the stud or make it less stiff."

I cannot conceive how such demonstration is to be made, except on the assumption that the part is equal to the whole.

As to the remark that "the strain on the neck, between the body of the stud and the nut, is tensile only," I have no general denial to make; and if "Easy Way" had read the text carefully, he would have seen that I had made no statement to the contrary, either directly or by implication. For the present purpose I am willing to accept such as the case, and upon it base our investigations as to the relative strength of the studs in question.

In examining the stresses to which the studs shown in Figs. 12, 13 and 14 are subjected, it should be noted that they were drawn to no particular scale, and not as examples of correct proportions, but to illustrate a principle. We will, however, consider them to be drawn on a scale of 3 inches to the foot, in which case the diameter of the bodies of all the studs would be $1\frac{1}{2}''$; the neck, in Fig. 12, would be $1\frac{1}{8}''$ diameter; the collars, in Figs. 13 and 14, $2\frac{1}{4}''$ diameter; and the neck, in Fig. 13, $1\frac{1}{2}''$ diameter, with a $1\frac{1}{8}''$ nut.

The analysis will necessarily involve the use of formulæ and the making of some assumptions, based primarily on the general theory of beams, which assumptions can best be considered by reference to the accompanying diagram (p. 5), which shows a stud of a diameter D, necked down to a diameter d, and loaded transversely by a weight P, at a distance L from the face of the supporting piece.

The load P causes a tendency to turn about the point S, which tendency is resisted by the pressure of the abutting surface against the lower half of the shoulder, and by the tension W in the neck extending through or into the plate.

If the tension in the neck is just sufficient to hold the shoulder fairly against the abutting surface, which it can be shown is the condition of maximum efficiency; the intensity of the pressure against the shoulder will be greatest at its extreme radius, decreasing to zero at the center, the upper half of the shoulder being subjected to no stress whatever. Referring again to the diagram, the variation in the intensity of this pressure is represented graphically by the shaded triangle, the side f of which is proportional to the maximum stress. This stress is sustained by a surface forming a semi-circular ring, so that the total load on the shoulder may be represented by the solidity of a wedge of which the shaded semi-circle is the base, and f the height.

This being the case the total pressure on the shoulder will be given by the equation

$$W' = \tfrac{2}{3}\left(R^3 - r^3\right)\frac{f}{R}$$

in which R is the outside, r the inside radius of the shoulder, and f the maximum stress to which it is subjected.

This load may be considered as concentrated at its center of pressure, which is in a line normal to the shoulder, passing through the center of gravity of the wedge.

The distance y of this point from the center of the stud is given by

$$y = \tfrac{8}{15\pi}\left(\frac{R^4 - r^4}{R^3 - r^3}\right)$$

The force W′ is resisted by the equal and opposite force W, which may be considered as acting through the center of the neck without serious error.

The equal forces W and W′ form a couple the moment of which is W y. This moment is equal to and balances the moment P L, of the load at the extremity of the stud, so that

$$P = \frac{W\,y}{L}.$$

If now we assume, as a convenient limit, that the maximum stress on the shoulder shall not exceed 12,000 pounds per square inch, we shall have for the total allowable pressure on the shoulder of Fig. 12, in which $R = \frac{3}{4}''$ and $r = \frac{6}{16}''$, 2,603 pounds, acting at a distance, $y = 0.522''$ from the center, which gives an allowable load, P = 226 pounds at the extremity of the stud.

The carrying capacity of a cylindrical beam of a diameter D, loaded at a distance L from the point of support, is given by

$$P = \frac{\pi}{32}\frac{D^3 f}{L}$$

from which it follows that taking f as before the body of the stud, if continuous into the support, would sustain a load of 663 pounds, or nearly three times that which obtains from the capacity of the shoulder.

"Easy Way's" assertion that the diameter of the neck "may be reduced below the proportion shown in the engraving without detriment" is correct as regards the form of stud which he so much admires, but the result of such reduction is simply to lessen the badness of an essentially weak construction.

The reduction may be advantageously carried to the point at which the capacity of the shoulder becomes equal to that of the bottom of the thread on the neck.

For standard threads, the limit is reached when the diameter of the neck is $\frac{7}{8}''$, when W = 3,616 pounds, $y = 0.486''$ and P = 293 pounds. The fiber stress at the bottom of the thread is 8,600 pounds per square inch.

But even with this proportion of neck to outside diameter, the capacity of the stud is less than one-half that which should obtain from the diameter of the body.

If the neck be reduced to $\frac{3}{4}''$, the capacity of the shoulder will be somewhat increased, but the neck will then be so heavily loaded that the stress at the bottom of the thread will have passed the assigned limit.

If we analyze in a similar manner the stresses to which the stud shown in Fig. 13 is subjected, we shall find that, with a collar diameter of $2\frac{1}{4}''$, the carrying capacity of the shoulder is 7,125 pounds, and that $y = 0.756''$, from which P = 900 pounds nearly, an excess of 36 per cent. over the capacity of the body of the stud.

If the diameter of the collar is reduced to $2\frac{1}{8}''$, the capacity of the shoulder will give P = 710 pounds, an excess of 7 per cent.

By this analysis is shown that, even with the best attainable proportions, the form of stud shown in Fig. 12 has a capacity of but 50 per cent. of that which it should have if its strength were not impaired by a "reduction which does not weaken it," while by the "better" construction its full strength is retained.

To point out this fact in a general way, but not to demonstrate it, was all that was intended to be done in the original article.

It is true that, like many other things which are intriniscally bad, the form of stud shown in Fig. 12 will "do;" but I must still dissent from "Easy Way's" positive assertion that it "is in all cases the best form of stud to use."

While the above calculations have been made on the assumption that the stress in the neck is wholly one of tension, whether or not this is the case will depend on the relative proportions of the different parts of the stud, and the character of the workmanship.

With approximately the proportions shown in Figs. 12 and 13, the stress in the neck is, without doubt, principally, if not wholly, tensile; but if the neck of the stud shown in Fig. 13 be somewhat increased in length, at the same time fitting tightly in the hole in the plate, the stress would become partially, if not wholly, one of bending. With the construction shown in Fig. 12, in consequence of the small capacity of the neck to sustain a transverse load, this would not be the case.

In answer to the criticism as to the increase in the number of pieces in Fig. 13, I would suggest that, while simplicity is a desideratum not to be lightly passed over, efficiency is of still greater importance; and that it is always a matter of consideration for each special case, whether the gain in the efficiency of any construction is sufficient to compensate for its additional complexity.

The importance of preserving the centers of turned work is entirely relative, and must give way when any greater advantage is to be gained thereby. Hollow shafting, crank-pins and studs have been and are being used by engineers of very good reputation, as has also the identical method of attaching a retaining washer, to which "Easy Way" so much objects. Moreover, the tapping of the small screw into the end of the stud does not necessarily involve the destruction of the center, as the countersink can easily be made sufficiently large to include the screw.

In admitting that the "advantage in stability gained by Fig. 13 over Fig. 12 is due to the increased base diameter," etc., "Easy Way" has admitted all that I claim, has, in fact, given his case entirely away.

Increase of bearing area and of the distance between its center of pressure and the center of the stud are the very objects sought for by the introduction of the collars of Figs. 13 and 14.

We shall be obliged to "agree to disagree" as to the relative merits of his "screw and thimble" and the stud shown in Fig. 14.

The screw and thimble is open to all the objections urged against the stud shown in Fig. 12, besides having some objectionable features of its own.

In point of strength it is equivalent to Fig. 12, taking D as the outside, and d as the inside diameter of the sleeve.

If the running piece be of cast iron, as is most usual, and the sleeve be also of cast-iron, in accordance with "Easy Way's" suggestion, we have then the not usually considered desirable combination of a cast-iron shaft in a cast-iron bearing.

Designers generally prefer to avoid tapping a bolt or stud into cast-iron when it has to be unscrewed, even at not frequent intervals.

In the majority of cases the piece into which are screwed the studs now under consideration will be of that material.

With the "screw and thimble" construction this unscrewing and screwing up must be done whenever it becomes necessary to remove and replace the running piece.

Neither of these objections hold against the stud so contemptuously dismissed as "abominable." What the objectionable points are and why the stud shown in Fig. 14, is "abominable," and for what reasons the "screw and thimble" "makes a good job," while the plain stud does not, "Easy Way" does not clearly state.

Of the two constructions, the screw and thimble is certainly the most expensive, as, in addition to the screw, which will not differ much in cost from the stud proper of Fig. 14, it includes another expensive piece, the thimble, which must be bored and reamed, turned on the outside, and both ends faced, to make which will surely cost more than the machine screw and washer of the "abomination," which by the way, is used regularly by at least one of the best and most widely known engineering concerns in the country.

As to the strong language which would be caused by the substitution of "the improved five-piece stud" for the "old two-piece style," I will simply say that Fig. 12 is a fair representation of the pinion stud formerly used by one of the best tool building firms in New England, while the stud shown in Fig. 13 is that adopted by them in their latest designs.

The change was the cause of no profanity as far as the writer has heard, nor, it is fair to state, did he have anything whatever to do with the change.

If "Easy Way" will demonstrate the incorrectness of the above conclusions, either by analysis or by actual tests, I shall only be too glad to acknowledge my "curious errors," but until then shall hardly feel like succumbing to the weight of his anonymous criticism.

A. J. SHAW.

Hardening Steel.

Editor American Machinist:

The letter of Mr. Richards, under the above heading—in which he records the fact that attempting to verify a statement made by me, in order that he might reciprocate the acknowledged service I had performed in agreeing with him, on the expansion of steel in hardening, proved instead, apparently, that I was all off on the subject—contains, aside from the fact that, after all, we disagree, several strikingly curious statements.

In the matter of the statement made by me in your issue of June 11, that "steel usually expands in cross section and contracts longitudinally in hardening, under different conditions of the steel as produced by working in the manufacture, or subsequently, and by annealing, also through differences in heat at which hardening is done, differences in temper—carbon contained—differences in size and shape of pieces hardened, recognizing the self-evident fact that in many cases, particularly in large pieces, purely mechanical causes have as much to do with the matter as do the chemical make-up, or previous condition of steel—differences in alleged expansion and contraction, even to absence or reversal of either, or both, appearing," I have nothing to take back or modify. I said "usually." I stand by that. Now, I suppose some critical reader will go back and read over what I am so ready to stand by, and will say, "Should think he might." Perhaps it is a rather elastic creed to pin one's faith to, and then, the word "usually" is so different from always, which I did not dare use. But here is just the thing that plagues the most of us in our wrestling with that indispensable, but alleged most perverse of all things which mechanics have to deal with. "Steel don't always act alike." Of course we meet now and then the fortunate individual who never has any trouble, has used the same brand of steel for thirty years, anneals it himself, doing it just the same now as he did thirty years ago, and has a dark room in which to do his hardening, does it just exactly so every time, and it comes out all right. But, he is too old fashioned. Hear this man. "I tell you a steel that has got to be heated just so for annealing or hardening ain't worth a cent. I want steel that will harden at a low heat, will harden if you don't happen to get it quite up to where you mean to, and at the same time if you happen to get it a little hotter, or a good deal hotter than you mean to, it has no business, if it's good steel to crack, and come to draw the temper it ought to make a good tool. I tell you, there is no use talking; when you harden steel as we do by the thousands of pieces, you can't watch every piece and get just such a heat, same as you would in hardening a lathe or planer tool. You've got to have a steel that will harden at all the different degrees of heat from a dark red up to a yellow—mighty near white sometimes—and come out all right. You've struck the wrong man to talk to about a just right heat at which to harden steel. What hurt does it do to heat steel? Don't we weld it?"

The above little address was for my es-

pecial benefit, and was intended to take me down a peg, the person who addressed the oracular statements to me following them up with the assurance that he knew just what he was talking about; had worked steel forty years, and had made it, doing all the different parts of steel making from the ore bed down to the finished bar.

Steel don't act always the same, lacks uniformity! Humph. But I am neglecting Mr. Richards. Let us look at the table he gives us. Four pieces hardened. Expansion, .0195″ .022″. .0245″, .029″ respectively. That the ratio of expansion should have been a continually increasing quantity from No. 1 to No. 4, or that there should have been so great a difference as between .00236 and .00356 need not seem strange perhaps. That is the way steel acts. "Varies so."

But let us look into the result of annealing and rehardening Nos. 3 and 4. We must admit that here was a strikingly curious display of both uniform action and lack thereof. According to the record, No. 3 contracted by annealing .0295″, in doing which it became shorter by .005 than it was before the first hardening. Still, very curiously, on rehardening it went back to exactly the same length 8.443 produced by the first hardening. This would tend to prove that hardened steel has its fixed volume, while annealed steel is variable, and that no matter what the starting point, hardening brings it back a second time to exactly where first hardening had drawn the line.

But here comes the conduct of No. 4 to upset our reasoning. Instead of going to .005 shorter than at first, it went to only .0005 shorter, and instead of expanding from that in hardening to just where it was before annealing, it stopped short by .0005. These tables are very interesting, not altogether for their record, but for the apparent confidence with which figures are used to the fourth and fifth place in decimals as representing, it is to be supposed, parts of an inch.

I have little to say about the thimbles. Betweeen the way they acted and the tables we have been considering, Mr. Richards has knocked the wind out of me pretty much. It looks as though I ought to reverse my statement and have the expansion longitudinal, and contraction crosswise, don't it? I suspect there will be other testimony, however, and I don't propose to change until it comes in. Now, as to "guess-work, being at sea, the little we know, pangs of shame, utter ignorance, no way of telling good stuff, unsafety of asserting that steel has been burned," etc., etc., let us look into this a little.

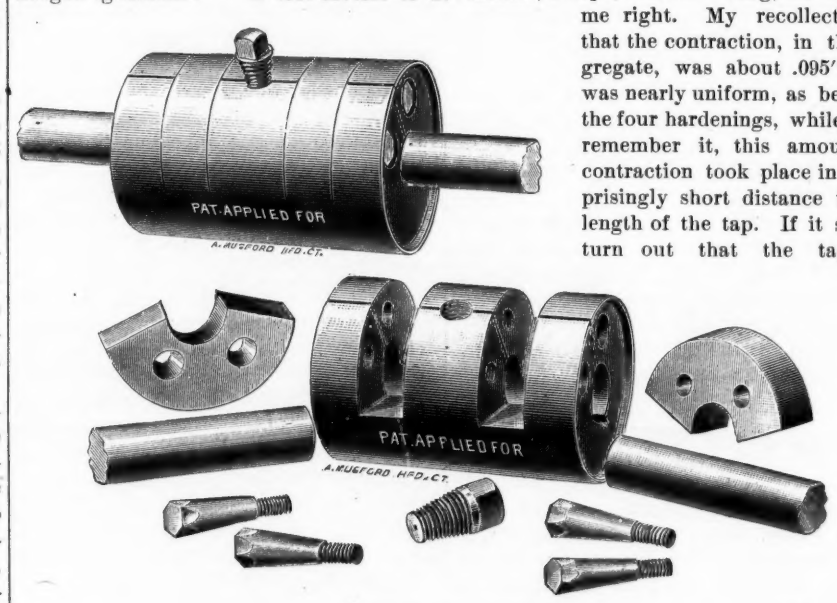
If I know that steel has been overheated, and take upon myself to tell Mr. Tooldresser so, or any other man, I expect to substantiate the charge. If not, what right have I to assume to know? I have a standard. An assertion backed up by actual proof is better than any denial. There is no invention needed to protect a man in making the charge that steel as judged by its condition after being hardened has been over-heated for hardening, if such was the fact. All that is needed is to learn to understand the index by which over-heated steel tells its own story. Invention needed! Why, a natural law governs the matter, which is as fixed and unchangeable as that of gravitation. Of course it is very easy to look on at all the variety of conditions in which steel is put, and say that our knowledge of it don't spread evenly; that we can't tell how hard a thing is, nor whether a pocket-knife is good stuff. Perhaps we can't, but we can know something. We know why we harden steel at all, don't we? If it was hard enough without we wouldn't harden it, would we? But the books teach that hardened steel is likely to break easily, therefore it must be tempered; softened to insure sufficient tenacity, and so a scale of colors are expected to guide us. Just here is the hardest pitch to get over in the hill of learning, steel-wise. We need to learn that steel is not, by hardening at a right heat, put n condition to break more easily. We can assume with entire safety if steel does break more easily, and shows as coarse or coarser grain than it did or would have done before hardening, that it was overheated. That the record of over-heating will be found in the strength, and in the grain of the steel, is unquestionable. It follows as an inevitable result of over-heating, that steel shall be made more brittle, weaker, coarser, or at least will have missed that most valuable of all results of hardening, refining by hardening. Really, Mr. R., you must be joking. With all the good things we have read from your pen, and your clear way of putting things, I think you must be "up" on all these matters.

And again, we are to expect better steel working and hardening from the novice than from the older, more experienced workman as a rule, are we? How does this agree with the facts? That there is "absolutely no standard to refer to by which to know when we are right, nothing but the memory of a color, and that resonance instead of luminosity might let us out of our trouble," reads well, but in face of the fact that there are standards by which brainy, thinking men gauge their action daily in hardening and tempering the thousands of tools and dies of steel, which in their serviceability are equal to the wonderful blades of Damascus, of which such awful lies have been told, why should steel temperers be taunted with alleged ignorance? "A tool-dresser is at his best at 40 or 45." That depends. He is at his best just whenever he can properly shape and properly work the tools he has to make, and to harden tools at a proper heat is imperative. Boys, you who are working and hardening steel, don't let Mr. Richards scare you. I don't care if you are not nearly out of your teens, you can learn to harden steel to be at its very best, and no man at any age can do more.

"Improvements in the processes of steel production have been all in the direction of cheapness, none towards improvement in the quality of steel." What object can there be in such a statement? Why, there has never been a time when so much really first quality steel was being made and used as at present. Steel is in use to-day which is doing twice, treble, fourfold, yes, ten times the work in the same time that could have been done with the best to be had forty years ago. In no direction mechanical has there been greater improvements than in the production of steel. Cheaper to take the place of iron, and to fill the thousands of intermediate places between iron and high grade steel; dearer, finer, better, to fill places and perform operations which increasing skill and close competition have developed. Better look into this matter a little before we decide that steel makers are on the retrograde. Now here is a puzzle. If there is "no means of knowing when Mr. Tooldresser overheats steel, and an invention which would enable one to charge him with his faults in that direction and substantiate the charge would be of more value than the coat of mail to the mediæval knight," how can the fact that "steel is often overheated by the manufacturer" be so easily determined?

Why would the over-heating of one be more apparent than that of the other, and why would not the denial of Mr. Steelmaker be just as strong defense as the denial of Mr. Tooldresser? How does the average steel consumer know when steel that has been "burnt" by the manufacturer should be discarded? What are the signs? Where do the bad effects show themselves, and how? Some of us who feel quite sure of some things, would like to know this

I am off from the main subject, I fear. Expansion or contraction by hardening is under discussion. How does this strike the reader who believes that steel expands in length, as a result of hardening? A tap on hardening showed such a discrepancy of pitch as to lead to critical measurement and comparison with an exact duplicate, not yet hardened. It was found to have contracted, as between a certain number of threads, over .020″. It was annealed and rehardened; the contraction was almost identical with that of the first hardening, or the distance between the threads, as measured, was over .040″, less than before the first hardening. After a third and fourth hardening the result was about the same. I am repeating this from memory, and as my informant is a reader of the AMERICAN MACHINIST, I hope, if I am wrong, he will set me right. My recollection is that the contraction, in the aggregate, was about .095″, and was nearly uniform, as between the four hardenings, while, as I remember it, this amount of contraction took place in a surprisingly short distance in the length of the tap. If it should turn out that the tap expanded lengthwise, Mr. Richards ought to know it from my informant, in order that the service can be reciprocated.



COMPRESSION COUPLING.

Up in the Naugatuck valley, "out in the woods" I remember hearing a New York city man say, not long since, sheet metal workers know something about shrinking steel by hardening. Thousands of dies are made and used in this valley, in which to "shrink" by rehardening is considered among the most valuable qualities steel can possess. Dies wear in use above the limit in drawing shells. These dies are only too large. Rehardening shrinks the hole, contracts the working part of the die, and by grinding out to standard size a practically new die is had. This shrinking is done over and over. If a die will not shrink every time it is rehardened, up to the time when it cracks from too many repetitions, the steel of which it is made is condemned as worthless.

S. W. GOODYEAR.

Failure in Tempering.

Editor American Machinist:

I would like to lay the following before your readers, in the hopes of getting light: Sometime since I had to make and temper two steel rings of the following dimensions: Inside diameter, 10½ inches; outside diameter, 12½ inches; thickness, $\frac{5}{16}$ inch. The rings were not continuous; that is, a space of 6 inches was cut out. The rings were made of Naylor's best cast steel, annealed, before finishing, in sawdust over night.

For tempering I had a cast-iron ring 14 inches outside diameter and 1 inch thick turned up on one side only. To this cast-iron the rings were nicely fitted and held by six $\frac{5}{16}$ inch screws, the holes in the cast-iron being enlarged to allow for expansion and contraction. I heated all together, dipped in lard oil, and when tested the rings were not hard enough, but were otherwise perfect. I heated again and plunged in warm water, when the rings cracked across from the screw holes.

I have studied the case, and have concluded that the water found its way under the steel rings at the screws, and that this caused the rings to rise, and the screws holding them caused them to crack.

I would like to know from some one of experience if I am right, and also how to temper such rings without breaking, keeping them true.

H. E. CHRISTMAN.

Shrinkage for Tire.

Editor American Machinist:

Referring to the article on "Standard Sizes for Locomotive Wheel Centers and Tires," AMERICAN MACHINIST, July 2, I think it would be an improvement to bore the tires to standard sizes (by gauge) then let the master mechanics or builders use their judgment as to shrinkage. The shrinkage given in the article referred to would not be enough for this division. We have used steel tires for 21 years, and have not had one come loose. Two only have broken, and these broke at the same place on the road; the cause was found to be a defective crossing. Since this has been fixed no trouble has been experienced. Following is the allowance we give for shrinkage:

Wheel Center.	Shrinkage.
62¼″	$\frac{7}{64}$″
56½″	$\frac{3}{32}$″
49¼″	$\frac{5}{64}$″
43¼″	$\frac{1}{16}$″

With these shrinkages the tire is used down to one inch in thickness.

W. J. MCCARROLL.

Delano, Penn.

Compression Coupling for Shafting.

The coupling which we illustrate herewith is the invention of John G. Shepard, 61 Pleasant street, Hartford, Conn. The principle upon which it grips the shaft will be better understood by referring to the manner of making it. The binding pieces being in place, the coupling is bored out about $\frac{1}{100}$ inch smaller than the shaft. After being bored, a mandrel $\frac{1}{32}$ inch smaller is placed in the hole, the binding pieces clamped down to the mandrel, the coupling drawn tight together on the mandrel, and the end holes for the binding bolts drilled and reamed. From the manner in which the coupling is constructed it will be readily understood that if it is placed on the shafts to be coupled, with key in place, and the binding bolts screwed up, it will have a firm grip.

The taper plug shown is used to open the coup ing a little when putting it on or taking it off the shaft; when the coupling is on, the plug is, of course, removed.

An enterprising market gardener in that highly cultured suburb of Boston, Cambridge, gets ahead of his competitors in the early spring by using steam for forcing purposes. His beds, it is said, have not only the glass coverings which are provided for ordinary hot-beds, but a novel arrangement in addition, in the shape of a system of underground steam pipes. These are for the benefit of uncovered beds as well as for those that are glass covered; so that in early May, when the ordinary hot-bed has gone by, the forcing process may still go on, even in uncovered out-door beds, by means of this "bottom heat" in the pipes. The plan is said to pay.—*Syracuse Evening Herald.*

The citizens of Indianapolis, Ind., are happy in the fact that plenty of natural gas is being found near the city. It is proposed to furnish it to the citizens for 10 cents per thousand feet.

AMERICAN MACHINIST

PUBLISHED WEEKLY

BY

American Machinist Publishing Co.

HORACE B. MILLER, Pres't.
JACKSON BAILEY, Vice-Pres't.
LYCURGUS B. MOORE, Treas. and Sec'y.
96 Fulton Street, New York.

JACKSON BAILEY, Editor. HORACE B. MILLER, Business Manager.

F. F. HEMENWAY, Mechanical Engineer.

The American News Company,
Publishers' Agents, New York.
The International News Company,
11 BOUVERIE STREET, Fleet Street, LONDON, ENG., will receive subscriptions for the AMERICAN MACHINIST, at 14/7 per annum, postage paid.

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NEW YORK, JULY 23, 1887.

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Prospects for Fall Trade.

Already manufacturers are looking forward to the prospects for business next fall. No one is wise enough to foretell what a few months may bring forth, but judging from the past there is every reason to expect a good fall trade; a trade that shall show decided improvement over anything in the past few years.

There are several reasons for believing this. The crops, on the whole, are likely to be good. In some localities the drought has worked trouble, but on an average the yield, acre for acre, will be high. And the increase in acreage will swell the total to an important extent. Railroads are already taking cognizance of the increased facilities they must furnish; there is every reason to believe that railroad business will be lively this fall.

In textile fabrics there is evidence that the demand will be well up to the supply. Surplus stocks have been worked off, and mills that have been idle are starting up with good prospects of success. The large number of mills in construction at the South point to close competition in the future, but this will not be likely to materially affect trade this fall.

In iron and steel there is absolutely no accumulation of stock. Furnacemen have just supplied the demand in iron, and as there is every reason to believe that there will be an increased demand, it appears that they must be busier later in the season. In steel rails, mills are behind orders to the extent that foreign rail makers have been enabled to place several very satisfactory orders. This will, however, right itself, and American rail makers will take care of American demands.

On the whole the prospects for a good fall trade were never better, and the only disaster likely to come to manufactures is from the anticipation of something akin to a boom, which will not come this fall. But there will be an increased demand for goods that means a gradual increase of the means of supply.

The New York Factory Law.

The factory law of the State of New York is now, owing to the appointment of a sufficient number of inspectors, likely to be rigidly enforced. This is a good thing, because enforcing a law is the only way of finding out whether it is good or bad. Laws similar to this have been and are still nominally in force in several States, but their enforcement has always been a farce. Like many other laws, there has been no intention of enforcing them.

This law applies to all manufacturing establishments where as many as five persons are employed. By one of its provisions no child under thirteen years of age shall be employed in any manufacturing establishment. This provision may sometimes appear to work hardship. There are undoubtedly instances where the wages—small as they are—of children under this age seem essential to the support of the family. But these cases are rare compared to those in which such children are compelled to work by improvident parents, and permitted to do so by the cupidity of employers. In any event, putting such babies at work in close factories is a species of murder that ought not to be tolerated in civilized communities. This provision of the law will be very generally acknowledged to be wise, on the ground that the State has a right to look after the physical and moral welfare of coming generations. There is a large surplus of labor in the world just now, and there is no excuse for putting the cradle under contribution for the benefit of anyone.

The New York factory act also provides that boys under eighteen and girls under twenty-one years of age shall not be employed in a manufactory longer than sixty hours a week. We do not see that any fault can be found with this provision. There are, we believe, factories where the hours of labor are longer, but these hours ought to be shortened, at least in the instance of children. This provision appears to be good, and altogether conservative.

Other provisions of the law regulate guarding against accidents, providing fire escapes, sanitary regulations, etc. A copy of the law must be posted in every room. Infraction of the law is punishable by a fine ranging from $50 to $100, or, if the fine is not paid, by imprisonment from thirty to ninety days.

The law will, we hope, have a fair trial, to the end that modifications may be made if found advisable. In some cases its enforcement may not seem to be the best thing, but no law could be devised, against which in isolated instances objections could not be found. For all that, this law may be as nearly perfect as it is possible to frame a law. It would be better if such matters could be left to regulate themselves, but abundant experience has proved that they cannot be so left with safety. Since a law on this subject is necessary, by all means let it be kept as far as possible from being a dead letter, then eventually it will crystallize into something that is right, if it is not right now.

The Railroad Question.

There are two ways of discussing the relation of railroads to the general public both of which are about equally wrong. In one view railroads are looked upon as the very essence of monopoly—the only object their projectors have in view being legalized and unlegalized robbery. The other view is that since railroads have done so much to develop the country they are entitled metaphorically—almost literally sometimes—to the earth. A sensible view of the case is that property in railroads should be protected just as any other property is protected; that railroad managers and owners are in no way above the law, and that when they take what does not belong to them they should be dispossessed of it in the quickest possible manner. The greatest cause of complaint there is to-day against railroad corporations is that the people elect lawmakers that can be bribed for an amazingly small amount of money into passing any kind of bills that are wanted. If honest men were elected to make laws, and these laws were rigidly enforced, there would be little cause of complaint against railroad corporations. The man who needlessly exposes his pocket book is about as blameworthy as the one who takes it.

If railroad corporations claim land that does not belong to them, their claim should be disregarded, just as it has been in some recent instances. Whatever they have a legal title to should be conceded, as it would be in the case of an individual. Those who argue that the law should be stretched to secure lands to railroads that they have forfeited their title to through non-performance of their part of the contract, are off in their argument, just as much as those are who propose stretching the law against railroads.

The talk about the great civilizing agency of railroads is the merest nonsense. Railroads are projected and built for the sole purpose of making money. So far as they tend to improve and civilize the country, that is something that belongs to the people, and not to the men who put one dollar into an enterprise for the sake of getting two dollars out of it. The cause of railroad corporations is only harmed by the attempt to pose those who own them as exemplars of the rare virtue of disinterested benevolence. The late Mr. Vanderbilt voiced the sentiment of railroad managers—rather profanely and with unnecessary bluntness—when he said, "the people be damned," and this is about the sentiment of the people towards railroad corporations. The whole matter is one of dollars and cents, just as all business transactions are; there is no more sentiment about it than there is in pork packing in Cincinnati or Chicago. All that is wanted is the strict enforcement of the law, and living up to the letter of the contract by both parties to it. Experience has shown time and again that railroad corporations will take all they can get; this is an almost universal weakness of human nature. The duty of the government is to see that they get only what belongs to them, and the public ask no more than this.

The Cost of Fire Protection.

There is manifest weakness on the part of the citizens of a great many towns in this country in not providing the protection against fire afforded by a steam fire engine. The cost to the business interests of a town from lack of means of dealing with fires is often ten times greater than the cost of such protection, and this cost has to be met just as surely and as regularly as the cost of fire protection; it is not something that can be put in the remote future and covered with a contingency. Insurance companies have recently shown that they have an excellent understanding of the value of fire protection, and in some States are discriminating with something like vengeance against towns that do not provide for putting out fires. But in this the companies are only acting up to common sense. It is cheaper to control fires than it is to pay for the damage they do, and the citizens of any town must do one or the other. It is not uncommon at the present time to hear of a fire loss in a comparatively small village seldom reached in large cities. As a matter of fact discrimination in insurance rates has been against property in cities provided with almost perfect means for controlling fires.

The great trouble in bringing about fire protection in small towns is the bugbear of cost. And in the main it is a bugbear. Viewing the elaborate systems of large cities, fire protection appears to be a costly luxury. Looked at as a simple matter of dollars and cents it is nothing of the kind. Compared with the increased cost of insurance where there is no protection, and with the menace to manufacture and general business, which keeps both away, to the great disadvantage of the locality, it is insignificant.

Without going into particulars an initial expenditure of from $5,000 to $10,000 and a yearly outlay from $1,000 to $2,000, which outlay shall include interest on investment, or sinking fund, will purchase a steam fire engine and the appurtenances required, put in cisterns, and maintain a very efficient fire-department, in proportion but little inferior to those in our large cities. It will reduce insurance and offer inducements to manufacture, paying for cost several times over.

We have no better suggestion to offer to towns that for lack of fire protection are likely to be wiped out any day, than to find out the cost of good fire protection, then compare this with the cost of getting along without it.

Literary Notes.

We have received from the Hartford Steam Boiler Inspection and Insurance Company, a bound volume of *The Locomotive* for 1886. It is a book of nearly 200 pages, full of matter of interest to steam users, and those having charge of boilers. This matter relates to current practice, and gives the latest experience and observations on steam boilers. The price is one dollar; sold by the company at their Hartford office.

A HAND BOOK ON THE TEETH OF GEARS. Their Curves, Properties, and Practical Construction. With a Bevel Gear Chart for Shaping Bevel Gears without Drafting. George B. Grant, 66 Beverly street, Boston, Mass. Second Edition, Enlarged.

The author of this book is a practical gear maker, engaged in the business of making gears, as well as a writer of recognized ability upon the subject of the teeth of wheels. In the present work he has clearly explained the processes of calculating and laying out the teeth of gears, in a way that can be understood in the shop. The processes are shop processes, and do not require translation before being used.

The present edition of this work contains the bevel gear chart, by the use of which bevel gear blanks can be shaped by the lathesman, without the necessity of making a drawing. This edition also contains several papers relating more particularly to the theory of gear teeth, which will be found interesting to the student. Rules for the strength and horse-power of teeth are also given. The book has been enlarged to about three times its original size, but is still sold for one dollar.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

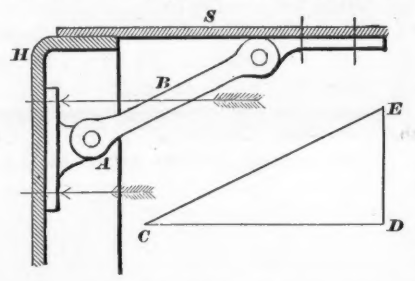
(310) H. I. J., Omaha, Neb., asks: Will a steam engine use more steam running at 225 revolutions than at 150, the work being the same in both cases? *A.*—That will depend upon circumstances. No intelligent answer can be given without knowing the kind of engine, the size, the load on engine and the steam pressure.

(311) J. G., Newark, N. J., asks: How can the internal bursting pressure of boiler tubes be found? *A.*—For short tubes in which the element of the length of the tube can be omitted, the following rule is used: Multiply the tensile resistance of material per square inch in pounds by twice the thickness in inches: divide this product by the diameter in inches; the quotient will be the bursting pressure. For long tubes the bursting pressure is less.

(312) P. J. F., Beaver Falls, Pa., asks: Do you think it safe to run a cast-iron fly-wheel 18 feet diameter, 22-inch face, 10-inch thickness of rim, held together as in sketch, at 100 revolutions per minute? *A.*—The sketch shows the rim at the joint, from which we infer that the wheel is made in halves. The fastening shown (on one side) consists of three 2-inch bolts through lugs, and three 2-inch rods passing over the joint in recesses in the outer edge of the rim; then the ends are turned at right angles and pass through the rim, having nuts on the inside. We assume the rim of the wheel will weigh, approximately, 40,000 lbs., which would make the centrifugal force 1,170,721 lbs. The 12 bolts and rods must then hold 372,650 lbs. The cross-section of these bolts and rods, allowing for the threads on the bolts, we assume to be 30 inches; hence the tensile strain is more than 12,000 lbs. per square inch. This is much too high for the bolts, and considerably too high for the rods. There is another point that should be carefully considered in fastenings of this kind. That is, the rods referred to are not likely to get much strain until the joint has opened somewhat, while the bolts are screwed tight, and have considerable initial strain. This may throw nearly all the duty of holding the halves of the wheel together on the six bolts, weakened by threading. We do not know how far the above may be true of this wheel; that will depend largely upon how the rods are fitted and put into place. The wheel may run for years, but we should not care to take the responsibility of running it. So far as the rim of the wheel is concerned, making allowance for the holes for rods, the breaking strain will be less than 1,200 lbs. per square inch; hence this part of the wheel should be quite safe. Built-up fly-wheels, when they give way, almost invariably do so in the fastenings.

(313) G. B., Utica, N. Y., writes: In your paper, March 26, 1887, an article was published written by James Heron, in which I am interested. What I would ask of you is to publish a standard system for constructing a locomotive boiler. I feel certain that such an article would be very interesting to the trade. *A.*—The article referred to simply shows a method by which the dimensions of a number of locomotive fire-boxes of different sizes can be kept on one drawing. This is accomplished by placing letters in place of dimensions on the drawing, and on the same sheet a table is given in which the dimensions are tabulated, which are to take the place of the letters on the drawing. This system can be very easily extended by making a drawing of the whole boiler, and writing letters in place of dimensions on the drawing and extending the table. This method of keeping the dimensions of similar mechanism was frequently and is now used to some extent, and before the blue-print process was known, saved considerable time in the drawing room. But with the blue-print process at hand a better method may now and is often adopted, and that is by making a tracing of the boiler or other mechanism, but leaving such dimensions out which may differ in similar boilers or other mechanism. From these tracings any number of blue prints can be made, and the true dimension written in the correct places on the blue prints. With this method a table is not used. The advantage of this method must be apparent. Two blue prints of a boiler are readily made, and the true dimensions written upon them. One of these blue prints is filed away for future reference, and the other is sent into the shop. In this manner an excellent record is kept, and the shop quickly supplied with good working drawings, and with very little expense.

(314) A. B., Newark, N. J., asks: 1. Please give me a rule for computing for the stress brought to bear on boiler braces at different angles. *A.*—In order to give an intelligent answer, let us take the following example: Let *S* represent the circular shell of a boiler; *H* a head, which is flat and must be stayed; *B* one of the boiler braces, which sustains the head *H;* and let the pressure at *A*, which the brace *B* must resist, be equal to 10,000 pounds acting in the direction of the arrows. The question now arises, What will be the stress on the brace *B* by *A*.—This problem can be solved in two ways—first, by a graphic construction, and secondly, by calculation. First, by graphic construction: Draw



a horizontal line *C D;* the length of this line must now be made to represent the given pressure of 10,000 pounds. This is done by adopting a certain length to represent a certain number of pounds; thus, for instance, we may say that 1/8 of an inch is to represent 1,000 pounds, or 1/4 of an inch is to represent 500 pounds, or 1/2 of an inch is to represent 1,000 or 500 pounds; in fact, the amount of pressure that 1/8, 1/4 or 1/2 of an inch is to represent is a matter of choice. Let us adopt 1/8 of an inch to represent 1,000 pounds; and now, since the line *C D* must represent 10,000 pounds, we must make the length from *C* to *D* equal to 5 inches—that is, 1/8"×10=5 inches. Through the point *D* draw a line *E D* perpendicular to *C D;* and through the point *C* draw a line parallel to the brace *B*, cutting *E D* at the point *E*. The length of the line *C E* will represent the stress brought to bear on the brace *B* in resisting the 10,000 pounds pressure at *A*. Now, since every 1/8 of an inch on the line *C D* represents 1,000 pounds, every 1/8 of an inch on the line *C E* will also represent 1,000 pounds, and consequently, if the line *C E* measures 5 1/2 inches, which is equal to 1/8"×11, we conclude that the stress in this brace *B* is 11,000 pounds; or, if the length of the line *C E* is equal to 5 3/4 inches, then the stress in the brace *B* is equal to 11,500 pounds. In short, the stress in the brace *B* is to the pressure at *A* as the length of the line *C E* is to the length of the line *C D*. If the stress in the brace is to be found by calculation, we again construct the triangle *C E D* as before. This triangle will be a right-angled triangle, and consequently we can find the length of the line *C D* by the following rule: Add the square of the line *C D* to the square of the line *E D;* the square root of the sum will be the length of the line *C E*. If the length of this line is found to be 5 1/2 inches, and we have adopted 1/8 of an inch to represent 1,000 pounds, then the stress on the brace is equal to 11,000 pounds. 2. To what extent is a boiler self-sustaining? *A.*—Only boilers in which all the surfaces are cylindrical, and which do not exceed a certain length, are self-sustaining. The safest way would be to assume that no boiler is self-sustaining, unless proved to be self-sustaining by calculation.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

New Book for Machinists. See adv., p. 16.

Link-Belting.

Send for catalogue of Link-Belting.

Over 50,000,000 feet of Link Belt in use.

Link-Belt Machinery Co., Chicago and N. Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Edw. Sears, Wood Engraver, 169 William st, N. Y.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

Air Compressors, Rock Drills. J. Clayton, 43 Dey st., N Y

Exhaust Tumbl'g Bbls. Henderson B's., Waterb'y, Ct.

For Improved Cooper Stoves, send to Variety Machine Co., Warsaw, N. Y.

Light articles built to order by the American Sewing Machine Co., Philadelphia, Pa.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y

Solid Nickel-Seated "Pop" Safety Valves. Consolidated Safety Valve Co., 111 Liberty st., Y. N.

Robbs' Patent Composition for case-hardening. Send for circular. F. W. Tasney, Paterson, N. J.

Davis Key-Seating Machines, kept in stock, by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

"How to Keep Boilers Clean." A book mailed free, by James E. Hotchkiss, 120 Liberty st., N. Y.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Injectors, Ejectors, Oil Cups, Sight Feed Lubricators, etc. Arthur Appleton, 45 Cortlandt st., N. Y.

For Sale—Very successful Single-Valve Automatic Governor Patent. Address Patent, AM. MACH.

20", 25", 28" B.G. and S. F. upright drills for immediate delivery. Currier & Snyder, Worcester, Mass.

Ice and Refrigerating Machines. 124 built, and all successful. David Boyle, 521 Monroe St., Chicago, Ill.

Drawing Materials, all kinds. Get catalogue. Mention this paper. G. S. Woolman, 116 Fulton st., N. Y.

The Improved Tabor Steam Engine Indicator, made and sold by The Ashcroft Mfg. Co., 111 Liberty st., N. Y.

Engine Lathes, Hand Lathes, and other fine tools. Assortment large; prices low. Frasse & Co., 92 Park row, N. Y.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Machinists' supplies, brass goods, m'f'rs' supplies, polishing materials, all kinds wire, metals, etc.; in any quantity. Jordan & Gottfried, 208 Canal st., N. Y.

For Best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N. Y. Send for des'n.

Curtis Pressure Regulators, Curtis Return Trap, Curtis Damper Regulator. See July 16, p. 14. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

The Holly Manufacturing Company, of Lockport, N. Y., will send, on application, their pamphlet illustrating pumping machinery and reports of duty trials.

Press for sale. Quick-acting; hole in bed, 8x5 punches to center of 13-inch sheet; 2 1/4-inch shaft; also four-spindle Drill. B. W. Payne & Sons, Elmira, New York.

Reed's Engineer's Hand-Book to the Local Board Examinations. Eleventh edition revised and enlarged, with 260 diagrams and 36 large plates. 8vo., cloth, $4.50, post-paid. Catalogue of books free. E. & F. N. Spon, 35 Murray st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines, and current practice in testing engines and boilers. Price, $2 post-paid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles—the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, the full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York

MANUFACTURES

W. S. Warner will build an ice factory at Palma Sola, Fla.

A machine shop is to be built at Belfast, Me., by Isaac Varney.

The Augusta Wrench Company will move their works to Oakland, Me.

It is expected that work will soon be begun on the Roanoke (Va.) Cotton Mill.

A new dry-dock is to be built at the navy yard in Brooklyn, at a cost of $550,000.

The National Tube Works, McKeesport, Pa., propose building another rolling mill.

All new manufacturing enterprises in West Point, Va., are exempt from taxation.

Wm. Kramer will build a carriage shop on Tenth avenue, north of 190th street, New York.

An electric light plant is to be built at Orlando, Fla. F. B. Pickering has the matter in hand.

E. Wilkinson is connected with a company to build an electric light plant at West Point, Va.

J. B. Snook & Sons will build a brick factory, 73x86, five stories, on Bank and West streets, New York.

The Tilden Paper Company, of Watertown, N. Y., will build a paper mill between Watertown and Brownville.

The Vosburg Manufacturing Company will build a large brick factory on State street, near Smith street, Brooklyn, N. Y.

The Springfield (Mass.) *Republican* says the Thorndike Company are to put in a large engine at their No. 1 Mill to use in case of low water.

Blain Brothers propose to build car shops at Jacksonville, Fla. Land has been donated, and stock taken in the enterprise by the citizens.

The Bonifay Brick Company, Bonifay, Fla., are increasing their plant, being so much encouraged with their first burning they are laying out a new yard.

The consolidated Brooklyn elevated railroad companies have given the Rhode Island Locomotive Works, of Providence, R. I., an order for 45 locomotives.

William Tod & Co., Youngstown, Ohio, shipped, last week, Porter-Hamilton engines aggregating 12,000 horse-power. They are building an engine for a blast furnace, with steam cylinders 34"x48', and air cylinders 84"x48".

The Boston Twist Drill Company has been organized at Saco, Maine for manufacturing and dealing in drills. Capital stock, $60,000; paid in, $300; par value of shares, $100. Geo. T. Clark, president; Alfred A. Brooks, treasurer.

Weber D. Updegraff, Pittsburgh, Pa., John M. Sweeney and Andrew T. Sweeney, of Wheeling, W. Va., and others, have incorporated the Automatic Packing Company, of Wheeling, W. Va., for the purpose of selling automatic packings for locomotives, and buying and selling machinery and apparatus of any description.

The Lewiston Locomotive Driving Wheel Company has been organized at Lewiston, Me., for the manufacture and sale of appliances connected with locomotives. The officers are: President, George P. Wescott; treasurer, James H. Smith; directors, James H. Smith, J. S. Ricker, George Burnham, jr.

C. A. Harrington is making extensive repairs upon his property known as the Faulkner Mills, at South Acton, Mass. The old water-wheels are being taken out and new ones from the Hunt Company at Orange are being put in. The flume is being rebuilt, and the old mill is to be raised one story. He should add a good steam engine, and have a complete plant.

Mr. Holmes is now busy making arrangements for his mattress factory at Bonifay. He proposes utilizing the moss so common on the oak trees to the south of us. It is well known that the mos contains hypnotic properties of no mean type. This industry is in its incipient state, and to Mr. Holmes, the enterprising pioneer of the business, there is money.—*Jacksonville (Fla.) News-Herald.*

The E. Ingraham Clock Company, of Bristol, Conn., have decided on building a new factory. It will be of brick, four stories in height, the ground dimensions being 300x60 feet. They are now putting up a factory for the manufacture of clock dials. It is 30x60 feet and two stories in height. The company now employs 300 hands. The new works will make double that number necessary.

Robert Worrell, of Summit, N. J., has brought out a village fire engine, the object of the invention being to provide complete apparatus in one machine. This consists of engine, hose cart, hook and ladder apparatus, etc., the arrangement being such that when water cannot be had by suction a tank can be filled from the forward part of machine. A new design of chemical engine is also to be attached.

The Vulcan Iron Company has been incorporated, with a capital stock of not less than $100,000 nor more than $200,000, at Richmond, Va. The plant will consist of the present establishment, owned by the company, and in addition thereto a rolling mill for making all the bar-iron used in the present establishment and some surplus besides. One of the principal objects of the formation of the new company is to do away with this disadvantage by the addition of the rolling mill.

Extensive additions are being made to the Johnson Steel Street Rail Company's works, at Johnstown, Pa. The forge department and the main building are each being enlarged lengthwise 50 feet. The addition to the forge department is now receiving the roof, while the walls of the main building's new part are just fairly under way. An addition has also recently been made to the office. The Johnson Company is experiencing a kind of boom, having so many orders they will not book any more to be filled prior to September. The works are in operation night and day, and 325 workmen are employed.—*American Manufacturer.*

A new branch of the pulp industry has been started at Skowhegan, Me., known as the Fiberite Manufacturing Company, to manufacture jars for electric batteries out of wood pulp. These jars are now made of rubber, which is expensive and wears out fast. The pulp, after leaving the pulp mill in sheets, is chemically treated by a secret process, and formed into jars under a pressure of 100 pounds to the square inch. The company has leased the old Lyon paper mill, and will equip it with machinery able to turn out 600 jars a day. An especial field for these new jars is in electric lighting, particularly on railway cars. Chas. A. Brown, of Portland, is located at Skowhegan as general manager, and the directors of the company are Col. F. E. Beath, of Waterville, and H. Butler and C. D. Brown, of Portland. Col. Heath is president and H. Butler treasurer.—*Industrial Journal.*

The Fossil Meal Company (A. Giese, proprietor) 48 Cedar street, New York, expect shortly to put on the market non-conducting bricks, composed of Wm. Berkefeld's fossil meal. These bricks will be of the same size and shape as ordinary fire-bricks, but weigh only one-quarter as much, making them specially easy of transportation. They will represent a new manner of using that material, and will be adapted for such purposes as bricking in the tops of boilers, owing to their non-conducting qualities and light weight; also for use in partition walls and ceilings of buildings, where light weight, sound-deadening and fireproof qualities are desirable. Bricks composed of similar material, but prepared somewhat differently, will also be put on the market for lining boilers and furnaces and similar purposes, taking the place of the ordinary fire-brick.

The *Telegram-Herald*, of Grand Rapids, Mich., says a new joint railroad station is to be established in the southern part of that city at the "Ward" farm. It adds: "A large number of prominent manufacturers contemplate a removal to this portion of the city, and among others who have already purchased the necessary ground, and are preparing to begin building at an early date, is a well-known and prominent manufacturer of mill machinery, who, with the increased facilities which the change will give him, will be enabled to furnish employment to about 150 regular hands. A prominent woolen manufacturer, whose immense plant requires ten acres of ground, finds the facilities in the city where he is at present located wholly inadequate for the rapid growth and prosperity of his business. He has exchanged several letters with Messrs. McKee & Cook, owners of the property in the vicinity of the new South Grand Rapids station, and it is more than probable that the vast woolen mills, with their several hundred employes, will be removed here at an early day. Other factories have expressed a determination to join the colony at South Grand Rapids."

The Richard Sauer Manufacturing Company, 4 and 6 S. Eutaw street, Baltimore, Md., write us they are about to build new works, and are making a study of factory plans and conveniences.

Machinists' Supplies and Iron.

NEW YORK, July 7, 1887.

At this writing the prospects look entirely favorable for good trade this fall. The crop prospects are more than fairly good, iron is in good demand, and the same may be said of manufactured articles in the supply line.

American Pig—Prices remain unchanged. We quote for standard brands No. 1 X Foundry, $21 to $21.50; No. 2 X, $19.50 to $20; Grey Forge, $17.50 to $18.50.

Scotch Pig—Prices are still firm in Glasgow. Sales have been made here of Coltness, $22 to $22.50; Gartsherrie, $21.50 to $22; Summerlee, $21.50 to $22; Eglinton, $20.50 to $21; Dalmellington, $20.50 to $21.

Antimony—Hallett's, 8¼c; Cookson's, 9c.

Copper—The market is quiet, without sign of change. Lake has sold at 10c., but bids are mostly 9.90c.

Lead—Prices are inclined lower. Sales have been made at 4.50c.

Spelter—Refined continues to sell at 5¾c. to 6c.

Tin—Jobbing lots of Banca have sold at 23½c., but are hardly obtainable at that figure. Straits and Malacca have sold at 23.45c.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate, 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

Engineer and draftsman, competent and reliable desires engagement. Address Box 42, AM. MACH.

Wanted—By an experienced patternmaker, situation as foreman. Address Box 39, AM. MACHINIST.

Foundry foreman of experience and ability desires a position; highest references. Address Box 38, AM. MACHINIST.

Competent mechanical engineer and draftsman wants responsible position. Specialties: Steam engines, mining machinery, steel-making machinery. Address B. X., AM. MACHINIST.

Boilermaker foreman, with long experience on all kinds of marine, stationary and rotary work, would like to have a situation. Address August Krumholz, 38 Montgomery st., Dayton, Ohio.

Wanted—A man to travel for sale of injectors oilers, lubricators and other boiler appliances must be posted in injector trade, and be a good salesman and have good references. Address J., care AM. MACHINIST.

Machinist of several years' experience would like situation where a knowledge of electric lighting would be of use; can design and build a first-class dynamo independent of existing patents. Address Electrician, AM. MACHINIST.

Wanted—A competent foreman for a machine shop (in a Western city) manufacturing mining machinery, engines, and doing general machine work. Address, stating age, previous experience, references and salary expected, D. F., AM. MACH.

Engineer and machinist, with theoretical training, competent to make duty tests of boilers and engines, and able to see to all kinds of repairs, is open for engagement; can show the efficiency of different kinds of coal—hard coal, hard and soft mixed, pea and dust. Address Steady, AM. MACHINIST.

MISCELLANEOUS WANTS.

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Crescent solid lubricant, clean, durable, cheap; prevents hot boxes. Crescent Mfg. Co., Cleveland.

The Crescent automatic grease cup is adapted to every service. Crescent Mfg. Co., Cleveland, Ohio.

Patent for sale; slide valve for direct-acting steam pump. Address Box 41, AM. MACHINIST.

Light mach'y of all kinds built at short notice Edmund Mills, 8 Dey st., Jersey City Heights, N. J.

Stationary boat engines, boilers, best, cheapest, 1 to 10 H. P. Washburn Engine Co., Medina, Ohio.

Punches, dies and special machinery built by C. F. Langston & Co., 70 No. 4th st., Philadelphia, Pa.

Wanted—The address of an importer or foreign manufacturer of weldless drawn steel tube. P. M. Sharples, West Chester, Pa.

Special tools and machines for mfg. designed and built to order; mechanical and Patent Office drawings. I. A. Weston & Co., Syracuse, N. Y.

Iron planer, 4x18 ft.; several large lathes; 3 cranes, complete; engines, boilers—will be sold cheap. Christian Hoffman, 223 and 225 Water st., Brooklyn, N. Y.

A. C. Christensen, mechanical and hydr. engineer, late chief draftsman for Henry R. Worthington. Designs and working drawings; also patent drawings. 26 Church st., R. 13 and 14, New York.

Wanted—To arrange with manufacturers of stationary boilers throughout the country to construct and put on the market my multi-tubular expansion boiler, of which the marine type is illustrated in July 16 issue of the AMERICAN MACHINIST. J. W. Walters, 162 South st., New York.

Manufacturing Business for Sale—I have a long-established commercial business which requires my entire time; I also own controlling interest in and have been managing the business of a corporation manufacturing a useful patented machine, demand for which is growing more general each year. In past five years 150 machines have been sold at prices ranging from $125 to $1,000; all are giving best of satisfaction. I want to dispose of the manufacturing business to some person or firm having the financial and mechanical ability required to extend the business, which can be made a large one. Will stand thorough investigation. Address Box 40, care AM. MACHINIST.

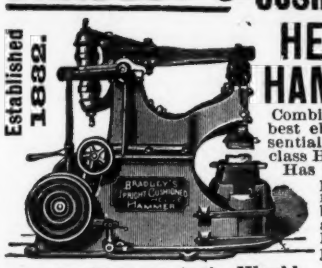
BRADLEY'S HEATING FORGES.

ESTABLISHED 1832.

For Hard Coal or Coke. Indispensable in all shops to keep **Bradley's Cushioned Hammers** and men fully employed and reduces cost of production.

BRADLEY'S UPRIGHT CUSHIONED HELVE HAMMER

Established 1832.



Combines all the best elements essential in a first-class Hammer. Has more good points, does more and better work and costs less for repairs than any other **Hammer** in the **World.**

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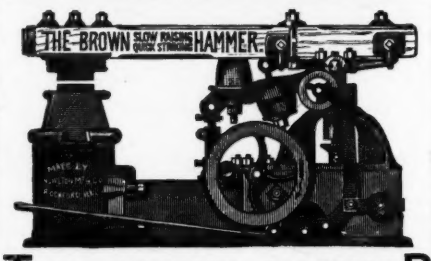

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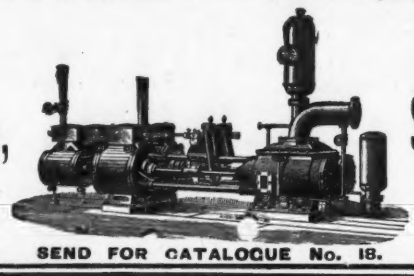

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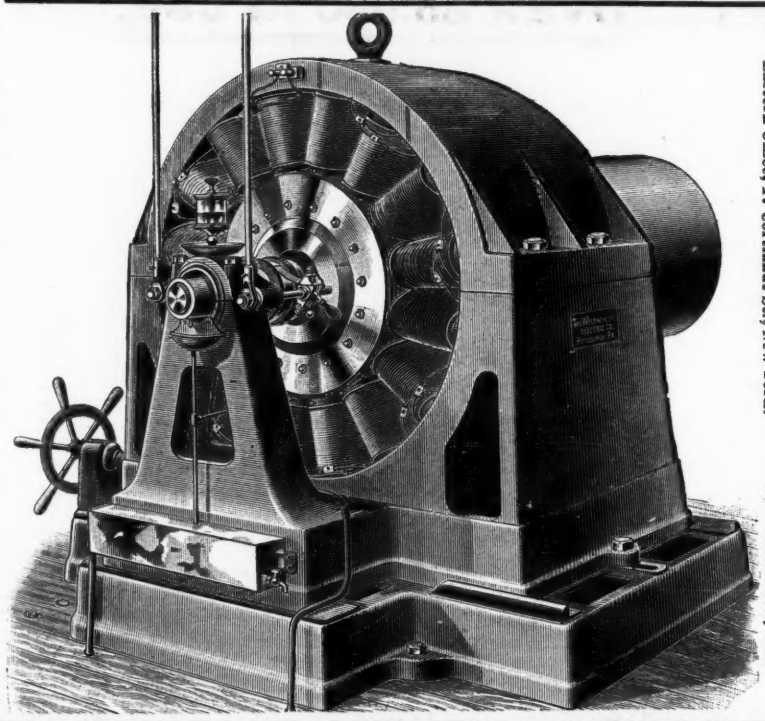

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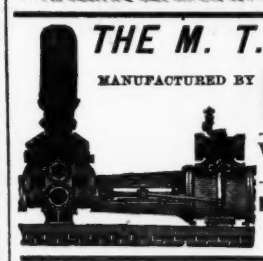

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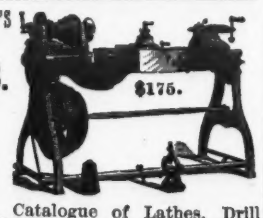

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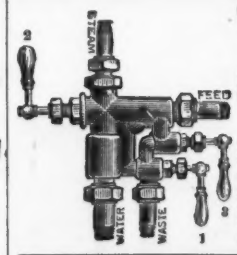

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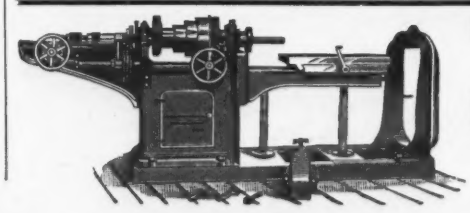

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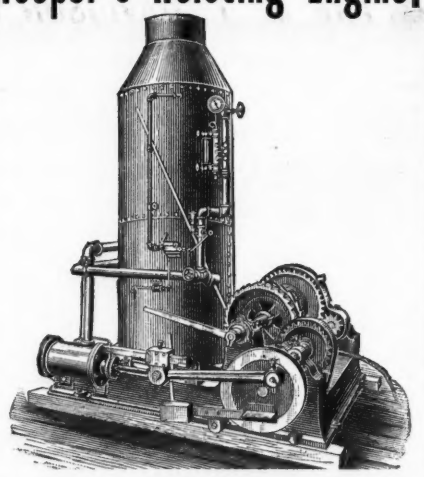

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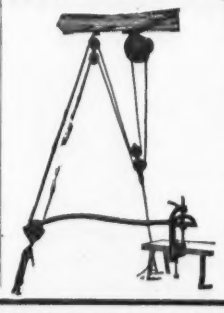

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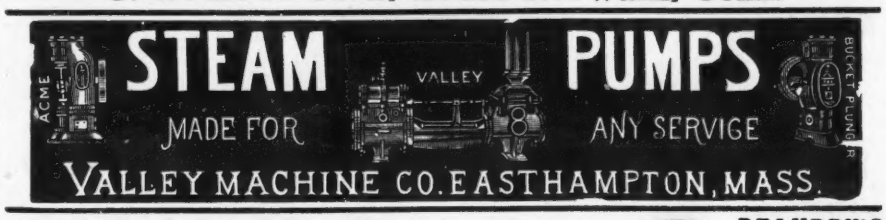

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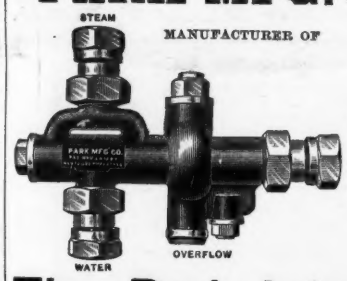

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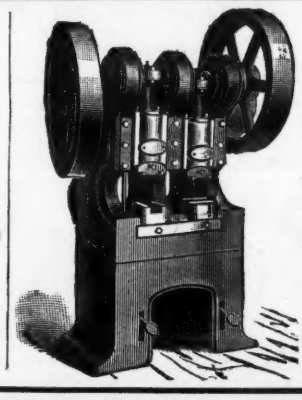

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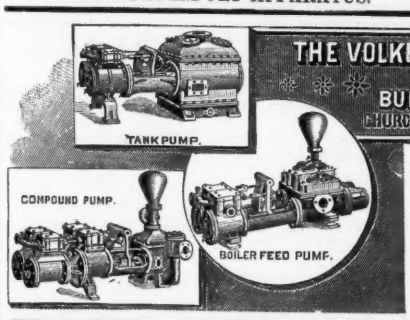

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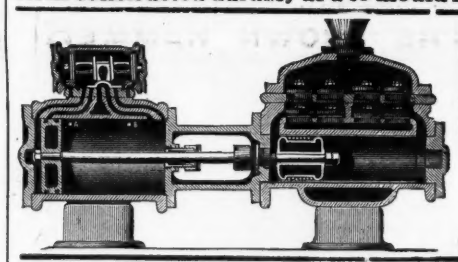

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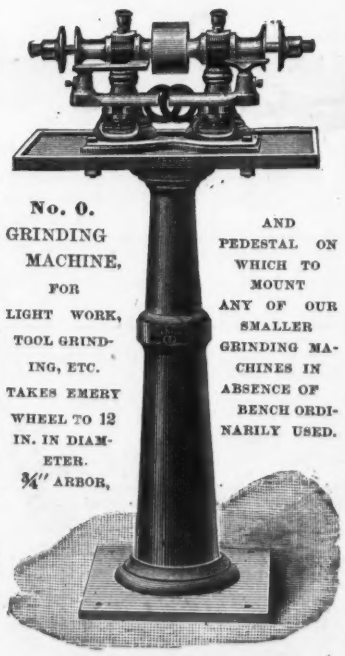

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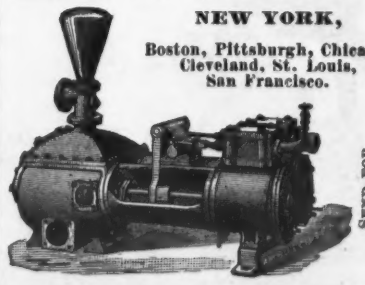

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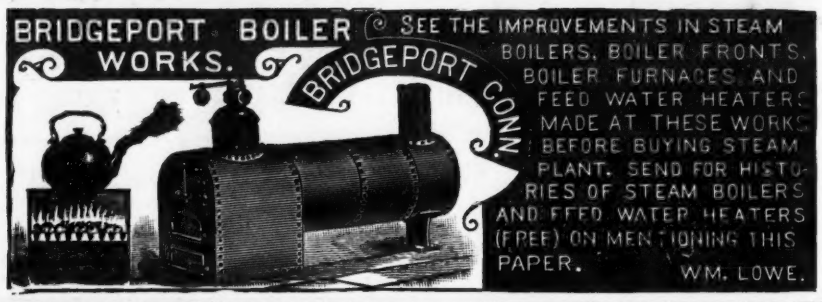
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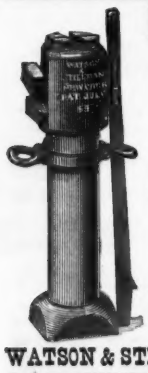

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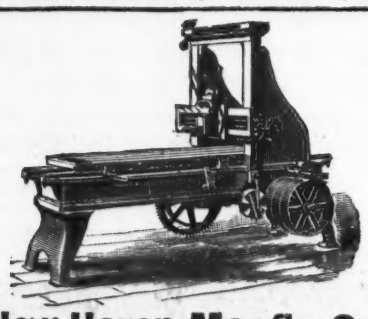

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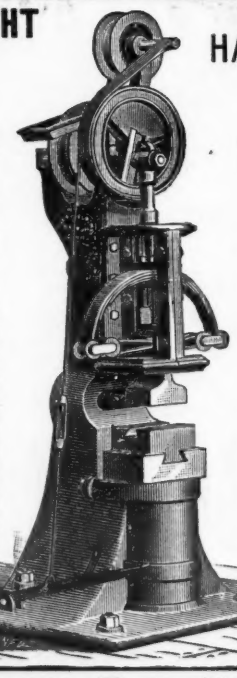

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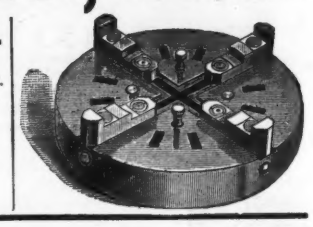

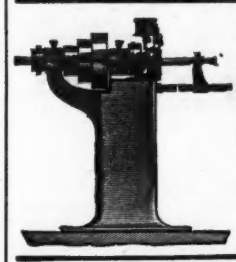

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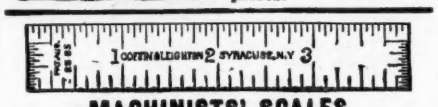

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Every Scale Guaranteed. Send for List.
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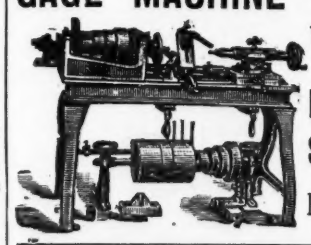

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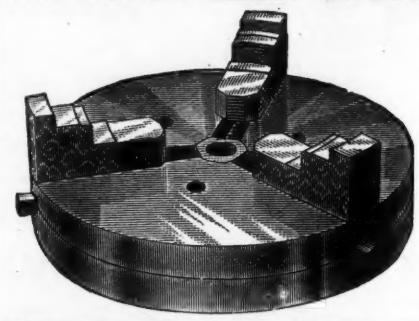

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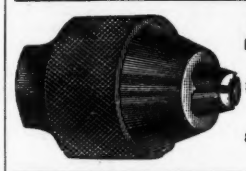

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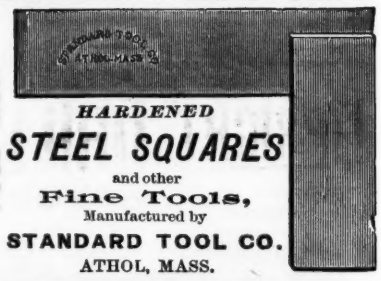

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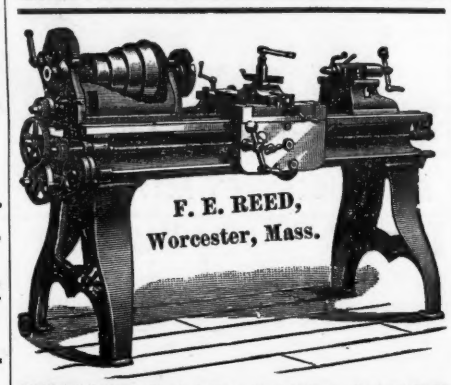

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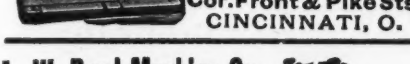

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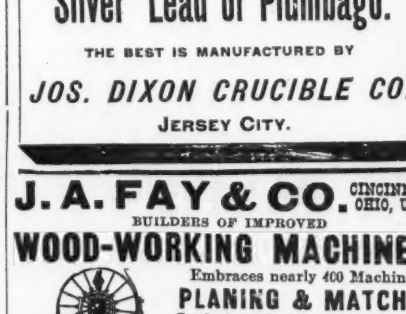

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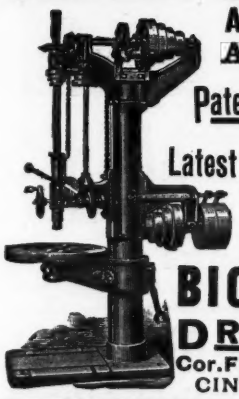

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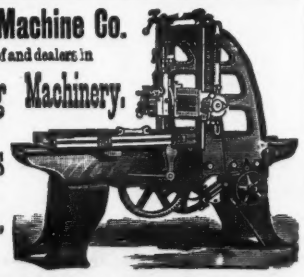

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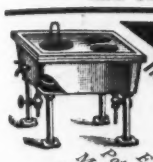

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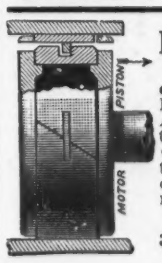

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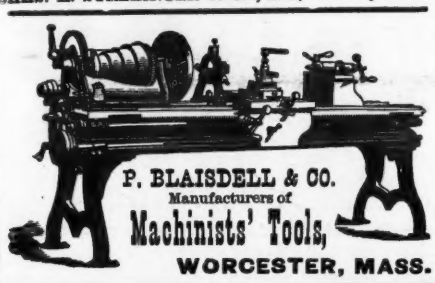

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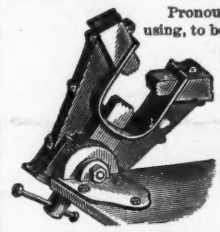

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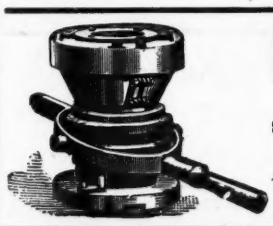

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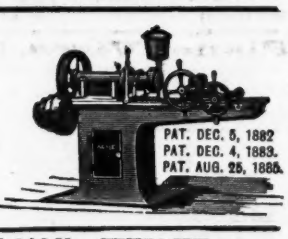

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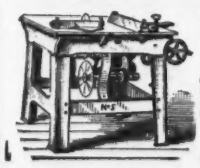

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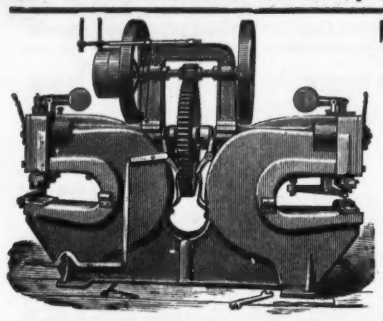

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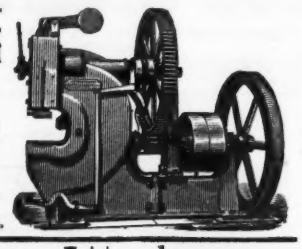

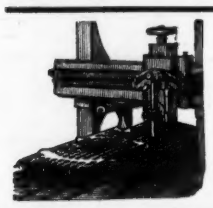

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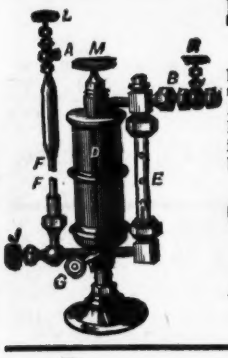

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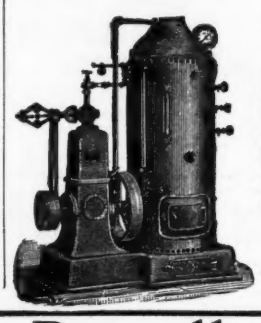

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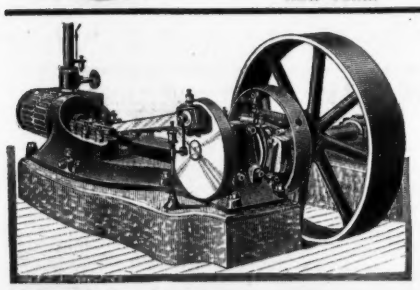

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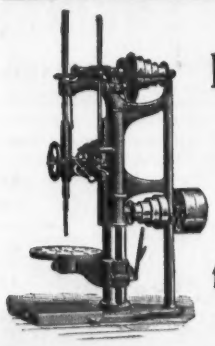

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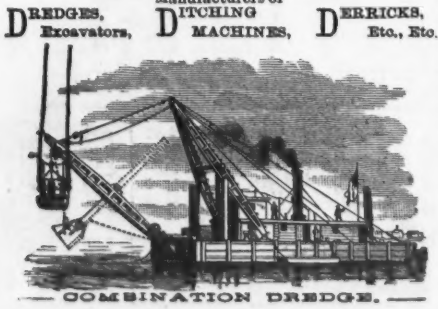

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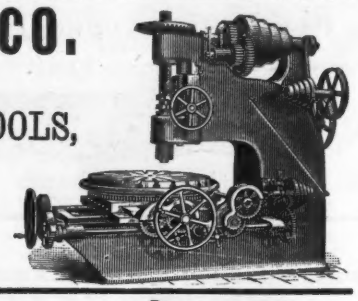

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The QUALITY and QUANTITY of work performed on these Planers is GUARANTEED to be UNEXCELLED by that done on the modern tools of the very best makes.

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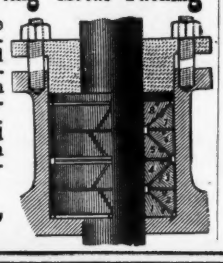

For Piston Rods, Valve Stems, etc., of Steam Engines, Pumps, etc., adopted and in use by leading engine builders, mills, iron works and steamship companies all over the world. Also flexible tubular metal packing for slip joints on steam pipes, and for hydraulic pressure.

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PORTER-HAMILTON ENGINE.

FOR HEAVY WORK AND LARGE POWERS.
EXTRA HEAVY DESIGN.
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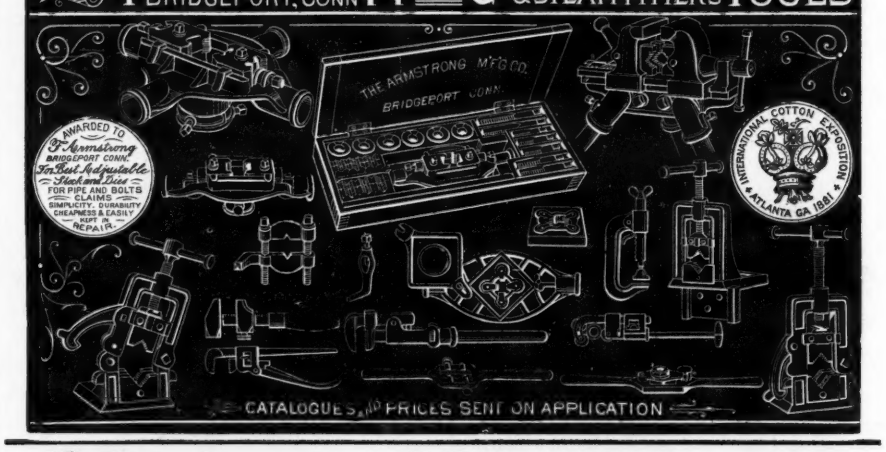

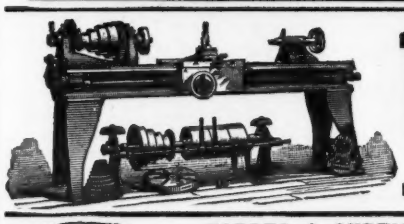

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12 sizes,
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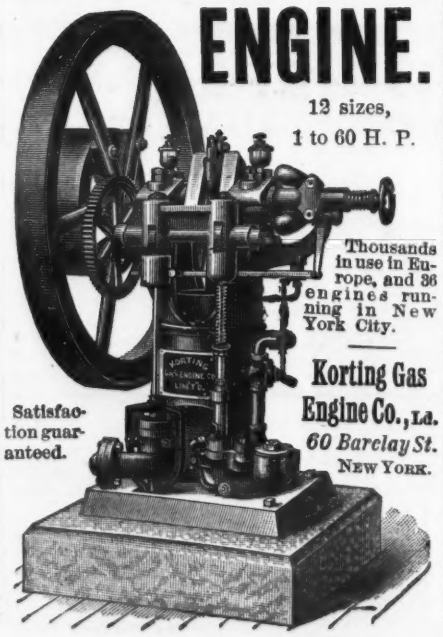

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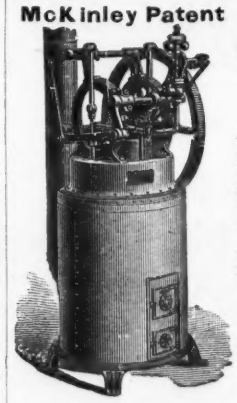

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Indicating Engineer and Mechanical Draftsman.
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One	16"	swing, 6' bed, Engine Lathe (Porter),	new.
"	17"	" 6' " " "	(Wright), S H.
"	Gray & Woods Planer, 26" wide, 14' long,		second hand.
Two	70 H. P	Stationary Boilers,	second hand,
One	60 "	" " "	"
"	70 "	Portable Engine,	" "
"	30 "	" "	New,
"	15 "	" "	"
"	85 "	Center Crank Engine,	"
"	12 "	" " "	"
"	20 "	Coil Boiler,	second hand,
"	Small Hydro Extractor	"	"
"	12 H. P. Vertical Engine,	"	"
"	15 "	" "	"
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With Circular Saw Mill, Saws, Belting and Fixtures complete, second hand.

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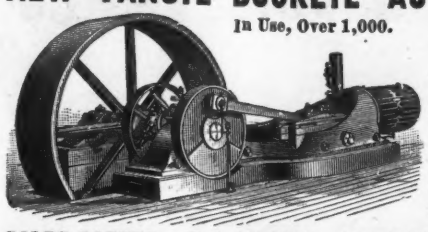
In Use, Over 1,000. 25 to 1,000 H. P.



These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H P for driving Dynamo Machines *a specialty*. Illustrated Circulars, with various data as to practical Steam Engine construction and performance, free by mail. **Address, BUCKEYE ENGINE CO., Salem, Ohio.**

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Sole Licensees and Manufacturers for New Jersey (South of Trenton), Eastern Pennsylvania, Delaware, Maryland and Virginia.

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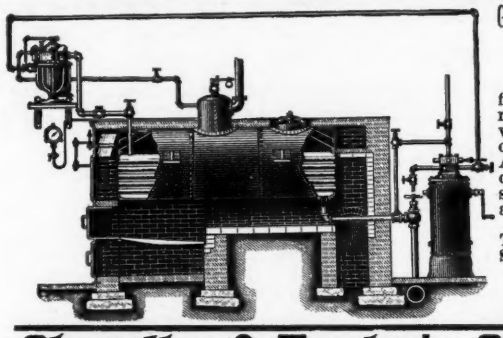

Guaranteed to Absolutely Prevent Formation of Scale in Steam Boilers.

Automatically takes water from the boiler, filters it, and returns it in pure condition, thus removing scale-making impurities from the water, and maintaining a free and steady circulation. Combines the well-known Albany Steam Trap with a Filter of novel construction, which has no rival in point of simplicity, facility for cleaning, and assurance against clogging of sand valve.

We also manufacture the **Albany Steam Traps and Blessing's Patent Renewable-Seat Stop and Check Valves.** Send for Circular.

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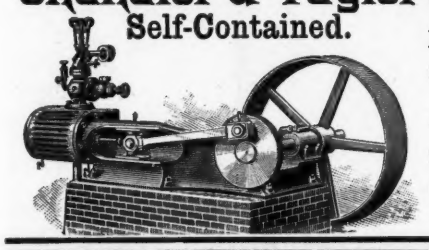

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Are designed for Heavy and Continuous Work.
May be run at High Speed when desired, performing the duties of High Grade Engines,
And are sold at the prices of ordinary Engines.

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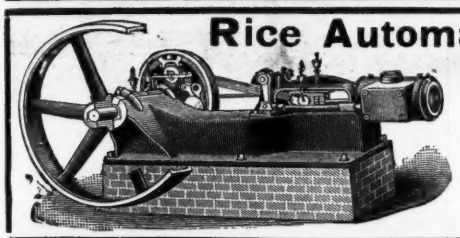

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Stationary Oilers. Best Economy.

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12 in. x 6 ft.	Engine Lathe,		new.
13 in. x 6 ft.	"	Ames,	"
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15 in. x 5 & 6 ft.	"	Wood and Light,	good order.
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19 in. x 12 & 14 ft.	"	Pond,	nearly new.
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16-18-20-23-25-28-34 in. Drills. 38 in. & 30 in. Radial Drills.
13 in. Stroke Slotter H. & P. new.
16 in. " Miles, Phila., A 1.
Center Bolt Cutter, new.
Merrill Drops, 400 and 800 lbs., good order.
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Milling Machines. Screw Machines, Slate Sensitive Drills. Gang Drills, and full line of all kinds of Machine Tools.
Send for list and specify what is wanted.

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We are now making from entirely new designs, *extra heavy* 19" and 21" Engine Lathes (the most popular sizes), of which we are making a specialty, and manufacturing in lots of not less than 100 at a time.

We make no charge for extras. Every lathe is furnished with *hollow spindle*; the 19" with 1⅝" hole, and 21' with 1⅞" hole. Every lathe has substantial *compound rest*, heavy tool post (bar steel), rest to turn full swing, *following rest* with adjustable jaws to take any size from 2½" down, with extra tool for shafting.

Full set of gears to cut from 2 to 18 threads including 11½ pipe thread. *Automatic stop on carriage. Separate screw and rod feed*, and the most substantial and easily managed *taper attachment* made. Cones and gears of large diameter and wide belt. Studs, screws and small gears are *steel or gunmetal*. Webbed live heads, heavy tail stocks. No worm or worm gears, no weak reverse plate. *Perfect lubrication for all running parts*, including carriage.

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GUARANTEE.

We guarantee this lathe to be equal in workmanship, truth, accuracy, solidity, material and finish, to the best made, and hold ourselves legally liable for this guarantee.

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Sizes Varying From

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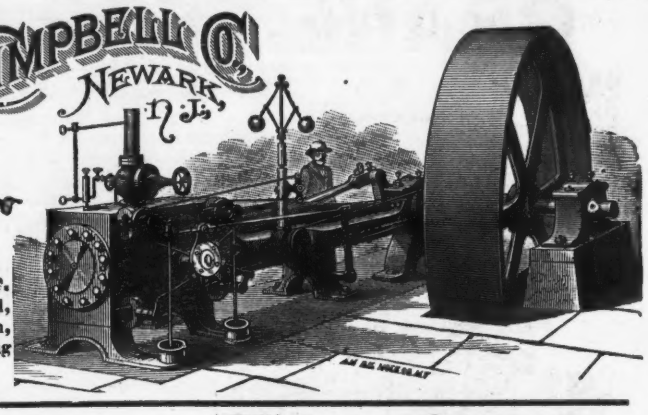

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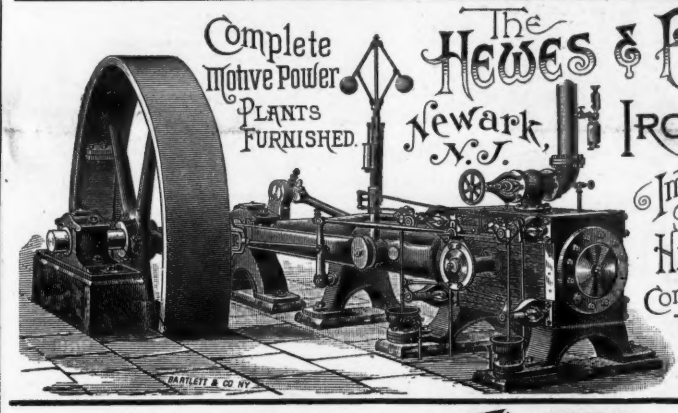
Complete Motive Power Plants Furnished.



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BUILT BY THE FISHKILL LANDING MACHINE CO.,

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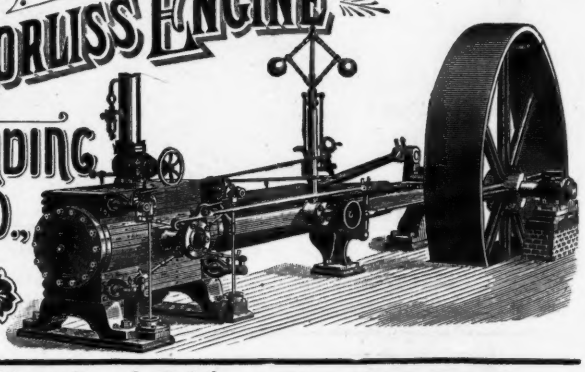

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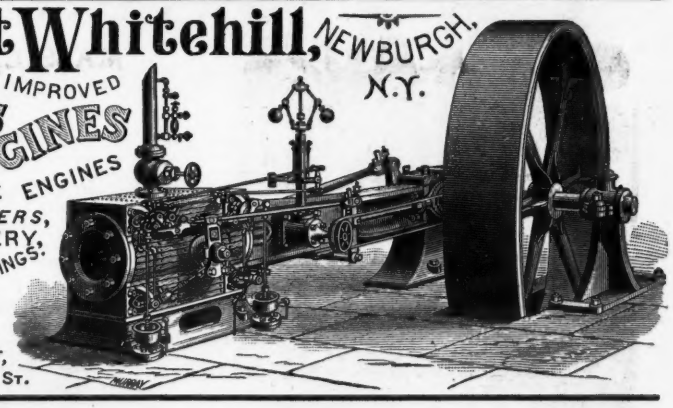

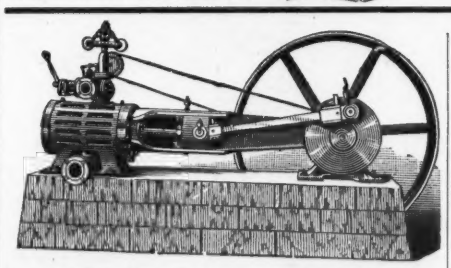

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Engines from 15 to 400 Horse Power.

Boilers of Steel and Iron supplied to the trade or the user. Send for Catalogues.

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We make a specialty of machinery for making Sugar, and furnish everything necessary to fully equip Sugar Refineries or Plantations. Satisfaction guaranteed, and patronage solicited.

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THE UNIVERSAL GRINDING MACHINE
MADE BY
Brown & Sharpe Mfg. Co.,
Providence, R. I., U. S. A.

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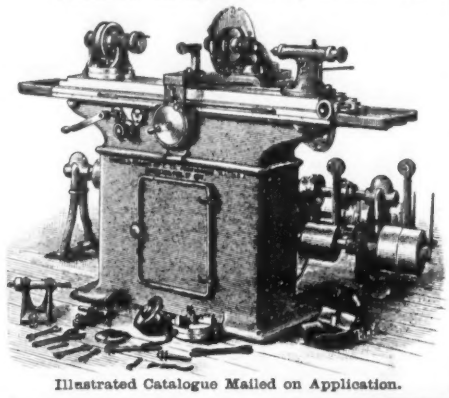
Brown & Sharpe Mfg. Co., Providence, R. I.
Gentlemen:—Having used one of your smaller Universal Grinding Machines for four years, and another of the larger size for nearly two years, it gives us pleasure to say that they produce economically and well all the kinds of work for which they are intended, and we could not dispense with them. Yours truly,
Wm. B. Bement & Son.



Illustrated Catalogue Mailed on Application.

Wm. Sellers & Co., Philadelphia, Feb. 7, 1885.
Brown & Sharpe Mfg. Co., Providence, R. I.
Gentlemen:—In reply to your inquiry of the 6th inst., we have to say that we have been using your "Universal Grinding Machine" almost constantly since June, 1880, with very satisfactory results. We hope to add more to our plant as business increases. Yours truly,
Wm. Sellers & Co.

Pratt & Whitney Co., Mfrs. of Machinists' Tools,
Hartford, Conn., Feb. 7, 1885.
Brown & Sharpe Mfg. Co.
Gentlemen:—We have had in use since Aug. 1882, one of your Universal Grinding Machines, and since then have bought two more. We find them indispensable in our shop. It has become with us pretty well understood, that there is no way to make a good journal bearing and other cylindrical surfaces, except by grinding. Such a machine must be perfect in its construction to answer the purpose. We find that these machines respond to all the requirements. Very truly yours, The Pratt & Whitney Co.,
F. A. Pratt, Pres't.

We have just published a Treatise on the Construction and Use of Universal Grinding Machines, fully illustrated. Sent by mail on receipt of P.O. money order for $1.33.

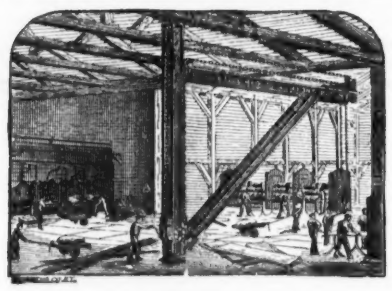
MACHINE TOOLS
—AND—
IRON-WORKING MACHINERY
OF EVERY DESCRIPTION.

Boring & Turning Mills,

Driving Wheel Lathes,
Hydrostatic Wheel Presses,
CAR AXLE LATHES,
CAR WHEEL BORERS,
SCREW MACHINES,
Universal RADIAL Drilling Machines.

IRON PLANER,
ENGINE LATHES,
Upright Drill Presses,
SPECIAL PULLEY TURNING LATHES,
Special Pulley Boring Machines, &c., &c.

NILES TOOL WORKS,
HAMILTON, OHIO.
NEW YORK, 96 Liberty St. PHILADELPHIA, 705 Arch Street. CHICAGO, 96 Lake St.



JIB CRANE.

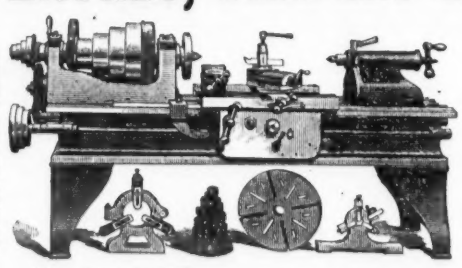
JIB CRANES,
ANY CAPACITY.
FOR HAND OR POWER.

Particulars on application. Full Specification and Tender promptly submitted on receipt of capacity, height from floor to support overhead and radius required.

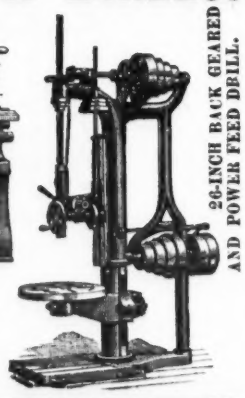
SOLE MAKERS,
The Yale & Towne Mfg. Co.
STAMFORD, CONNECTICUT.
New York—Chicago—Philadelphia—Boston. Catalogues on application.

ENGINE LATHES, SHAPERS & DRILLS.

20-INCH LEVER DRILL.



20 in. Upright Drill.
24 " " "
26 " Back Geared and
30 " Power Feed
38 " Drills.



26-INCH BACK GEARED AND POWER FEED DRILL.

LODGE, DAVIS & CO.
CINCINNATI, OHIO.
Send For Prices. It Will Pay You.

GOULD & EBERHARDT,
Near Market St. Depot,
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EBERHARDT'S
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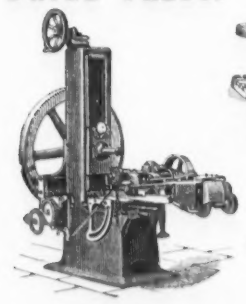
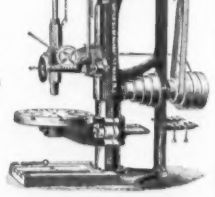
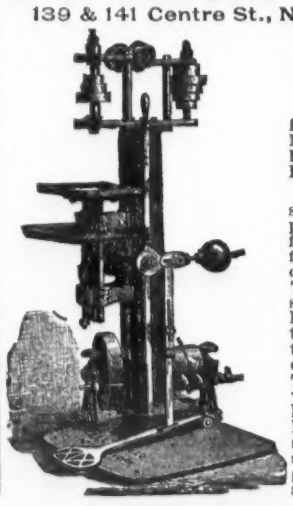


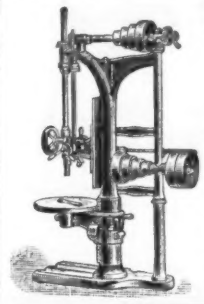


EBERHARDT'S
Patent
GEAR CUTTER.
Sizes, 18", 25", 36", 50", 60", 84".

E. E. GARVIN & CO.,
139 & 141 Centre St., New York,
Manufacturers of
Machinists' Tools,
Including Milling Machines, Drill Presses, Hand Lathes, &c.



The machine shown in cut, is especially designed for jobbing, and is fitted up with one or two spindles. Those with two spindles have pulley, with two sections, which gives two speeds to each spindle. Those fitted up with one spindle have a cone pulley with three sizes. The back shaft has a cone pulley with four sizes.



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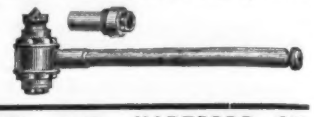

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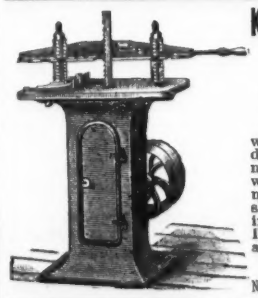

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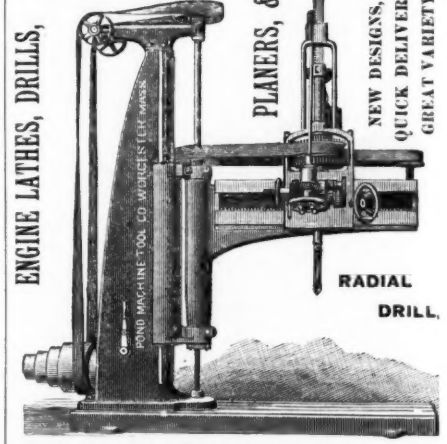

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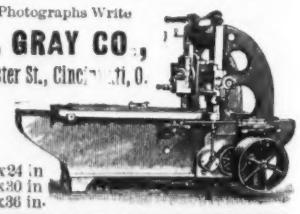

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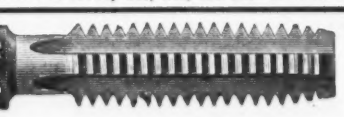

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